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EXPERIMENTAL APPROACHES TO PROBLEMS OF EARLY DEVELOPMENT IN THE RAT

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INTRODUCTION

ALTHOUGH it was logically deduced that mammals develop from eggs, it was not until von Baer, in 1827 described the human egg, that the expression "omne vivum ex ovo" was demonstrated as having universal significance. In the years since that time, the workers in embryology and reproductive physiology have added amazingly to the analysis of the factors involved in the bringing of a new organism into being.

Following von Baer's discovery, as Pincus (1936) has pointed out, the living eggs of mammals were scrutinized by many investigators. The yield of actual knowledge was small because of the difficulties of handling the material and because no correlation of developmental processes with those of the adult organism as a whole could be made. The discovery of the egg was made in advance of the scientific knowledge necessary for the correct interpretation of those interrelationships within the reproductive system itself which must be understood if developmental phenomena are to be correctly evaluated. It is small wonder, then, that with the development of fixation and staining techniques, the embryologist preferred to study the dead, static, and therefore unchanging entity which had been an egg and which had once contained within its small substance the agents responsible for the dynamic actions occurring in the nucleus and cytoplasm resulting in the new individual. It was more practicable to consider the egg fixed within the ovary in various steps of its maturation, than to attempt under the conditions then current to trace a single living ovum throughout its entire living history. Nevertheless we owe to those painstaking cytological workers, studying stained and fixed materials, a vast debt for making possible the attack of today, in which cytological study is an indispensable adjunct to the interpretation of the living object.

The experimental work on the mammalian ovum was begun near the turn of the century, when Heape (1890) transplanted rabbit eggs in order to investigate the problem of telegony. Brachet (1912, 1913) cultivated rabbit embryos, taking advantage of the technique afforded by Harrison's (1907) work on the outgrowth of nerve fibers, and this method has been used to great advantage by Lewis and Gregory (1929), Lewis and Hartman (1933), and Lewis and Wright (1935), on various mammalian forms. In addition there have been other studies (Nicholas, 1938, 1942; Nicholas and Rudnick, 1933, 1938; Defrise, 1933), correlating embryonic differentiation with the interactions of the various parts of the reproductive system and the limits of time during which embryonic events take place.

Huber (1915) clearly established the timing of various embryological phases of the rat. Since his study, the standardization of oestrus techniques first indicated by Stockard and Papanicolaou (1917) and applied to the rat by Long and Evans (1922) has assisted amazingly in shortening observational procedures, and in rendering more accurate the estimation of embryonic age. These

methods are now standard procedure wherever work on the reproductive system is carried on and wherever embryonic staging is of significance. Their accuracy has been tested in various forms, by measuring electro-potentials (Nicholas and Carmosino, 1944) or associated thermal changes (Barton, 1940), and by actual observation of ovulation (Hammond and Walton, 1934; Hill, Allen, and Kramer, 1935).

Coincident with the development of these methods and probably because of the accuracy made possible by them, came the correlation of the endocrine factors which control reproductive activities. The story of this phase of reproductive physiology is too long to give here in detail. Suffice it to point out that the demonstration of hypophysial control of the ovarian cycle as shown by Smith and Engel (1927) and Zondek and Ascheim (1927), opened a new vista to those interested in reproductive mechanisms in general, and the process of development in particular. The interrelationships of the ovarian secretions demonstrated by E. Allen *et al.* (1924), W. Allen and Corner (1929), and many other workers, have given the embryologist new facts in the light of which transient embryonic reactions can now be interpreted.

It was during the period of technical standardizations for the study of oestrus and the beginning of analysis correlating the activities of the reproductive system with endocrine factors that there appeared from three separate laboratories reports dealing with what was then an unusual approach to the problems of the mammalian fetus; these appeared practically simultaneously in three different journals. Swensen (1925), then at the Wistar Institute, employed carotid ligation as a method for immobilizing the pregnant rat while testing the motility of fetuses. Bors (1925), in Grosser's laboratory at Prague, performed intrauterine amputations and kept the living fetuses through gestation to birth, and similar experiments were reported from the Anatomical Laboratories of the University of Pittsburgh (Nicholas, 1925). This review will follow mainly the course of the experimentation that developed from these beginnings.

TRANSPLANTATION OF OVARY

Many embryologists have combined their efforts to give us clear observations on the early history and formation of the mammalian egg (Parkes, 1926), and experiments in which the ovary has been transplanted in order to study systemic effects have been frequent (Steinach, 1920). Those in which the study of the ovary has been related to developmental characters have been few. Guthrie (1908) transplanted the ovary in hens to test the effects upon the offspring; Castle and Phillips (1909, 1911, 1913) performed similar experiments on rabbits and guinea pigs. Robertson (1940) tested the factors concerned with development of the phenotype in the yellow mouse. He transplanted ovaries from heterozygous yellow into recessive agouti mice, securing more than 50 per cent of his transplants in a functional state as tested by the production of living young. These experiments yielded as their main result the fact that the failure of the homozygous yellow mouse to develop is a contingency of its genic content and is not a result of the heterozygous uterine environment per se. It likewise gave, as a secondary result, one of the best series of pre-implantation and early implantation pictures that we have so far secured; the yellow mouse embryos are normal in their development through the blastocyst and early implantation stages.

The ovaries so transplanted gave rise to second litters, showing that such a transplant can be maintained and continue to function under the influence of a foreign hypophysis, apparently entering into a functionally satisfactory relationship with the constantly varying uterus which the transplant controls through its own secretion. It is true that closely related individuals were used for this work on the ground that the closer the relationship, the greater the opportunity for study of the principal feature of this problem; but there is no reason why the attack so successful here should not be applied to organisms in which problems of species specificity could be attacked, in order to approach this unsettled and important problem in a truly critical way, (cf. L. Loeb, 1945). The work reported above showed not only that the young produced after transplantation of the ovary were normal unless a lethal genotype was produced at mating, but also that the transplanted ovary functioned and the tubal and uterine physiology were properly tuned and timed for the propagation of the embryo.

With the thesis that investigation of activity and changes within the individual parts of the reproductive system might yield facts necessary for the interpretation of important interrelation-

ships, Alden (1942a, b, c) undertook his studies of the import of the periovarial sac in the rat. This capsule, which from its embryonic formation is a sheet folded around the ovary, is at certain stages in the oestrus cycle a closed capsule, while at others it is frankly patent to the abdominal cavity. The mechanism which acts as a closing valve is formed by a folding of the tubal ostium. Alden (1942c) found that whereas closing of the periovarial sac produced cystic structures within the ovary and frequently distorted the oestrus picture, there was no interference with tubal or uterine reaction unless the fluid pressure of the cyst brought about functional deficiencies in the ovary. The surgical closing of the periovarial sac, then, does not of itself create a block to development, but it may do so secondarily.

In another study (Alden, 1941a), the eggs were followed in their course through the tube. After ovulation, the ovary was removed; in spite of this the eggs were transported in normal time through the tube and were expelled into the uterine cavity at approximately the normal stage. This fact seems to point to a negligible effect of ovarian hormonal substances upon the segmentation of the tubal egg during the time limits investigated. The eggs, when locked in the fallopian tube, become blastocysts, but so far implantation in the tubal mucosa has not occurred.

ENDOMETRIAL CHANGES

In recent years, the staining reaction of cells has acquired a new significance, in that certain chemical substances which react with specific dyes have been more carefully studied; for instance, basophilia in its characteristic appearance (Wislocki and Dempsey, 1945) is now related definitely to the content of ribonucleoprotein in the cytoplasm. The intensity of the staining reaction is a crude quantitative measure of the amount of chemical substances present.

Wislocki and Dempsey have found that the epithelial tissues of the uterus in all the animals examined exhibit varying degrees of basophilia. Apparently no rule for the regional staining reaction of the epithelium of the reproductive tract can be laid down, since in the sow the glands stain more deeply than the surface epithelium, while in the guinea pig and cat basophilia is more manifest in the surface epithelium than in the glands. In general, however, basophilia within reproductive structures increases during pregnancy. While the uterine connective tissue is usually not basophilic, there is an intensification of cytoplasmic staining just before implantation in the guinea pig and rat, which is followed by a reduction in the amount of staining as the stroma is transformed into decidua. In regions remote from the implantation site, the stromal cells remain basophilic during the same stage.

The same authors have examined the uterus for the localization of iron-containing substances by means of the Turnbull blue reagent. During pregnancy, all the forms studied, except the cat, showed the presence of iron-containing substances in the glandular epithelium. These substances are present in the lumen of the glands as well as in the epithelium, and are not found in the nonpregnant uterus. From the material at hand the exact time in the gestation period when iron first appears is not ascertainable, nor is it known whether its first appearance coincides with the onset of pregnancy. It is known, however, from the response of the endometrium to progesteron, that the cells of the uterus are remarkably fine indicators of hormonal reaction and make rapid responses, reacting to low concentrations of hormonal substances. It is possible that the basophilia in the glandular epithelium is directly correlated with the luteal secretion, which has been shown by Everett (1945) to reach its maximum in late dioestrus, coinciding closely with the slight delay in the first manifestations of implantation.

The Bodian technique, so well known as a method for silver impregnation of nerve fibers, has been used by Wislocki and Dempsey as an indicator of calcium in the uterine tissues. There is tremendous species variability in this reaction. Calcium is abundant in the surface epithelium and uterine glands of the cow, less in the cat, and exceedingly little in the rat. It has not been found in the surface epithelium of either guinea pig or man. In both the sow and the cat, argyrophilic granules are supranuclear in the glands; in the sow the granules are diffuse in the surface epithelium, but in the cat they are concentrated near the apical surface. In the pig, rat, and human, the stroma shows granular material only at the junction of fetal and maternal tissues.

The distribution of acid phosphatase has also been studied. Atkinson (cited from Alden, 1947a) has found that the distribution of acid phosphatase is the inverse of the fat relationships studied by him. The glandular and surface epithelia of

pregnant rats contain acid phosphatase, which is also found free in the uterine lumen, a fact indicating, according to Wislocki and Dempsey, an active secretion of the uterine epithelium. Acid phosphatase has been found only in the endometrium of the sow and cat. In the sow, there is no acid phosphatase present in the non-pregnant form.

Alden (1947a) has studied the amount of fat present at various stages in the oestrous cycle and also under varied experimental conditions. He found that there is practically no fat in prooestrus but that there is a large amount at the mid-interval. During early pregnancy fat accumulates in the epithelial cells, and there is an alteration of the fat at the implantation site, a change which may result in its utilization by the embryonic trophoblast.

In the rat (Krehbiel, 1937) there is fat present in the surface epithelium and in the uterine glands, as well as in the stroma at implantation stages. Its presence has been thought by many to be a result of a degenerative process in the tissues, but the nature of its distribution is such that this explanation is unlikely. It is certain (Krehbiel 1937) that the amount of lipoid increases after ovulation and before implantation, and Wislocki and Dempsey have found that even during follicular phases of oestrus it is more readily demonstrable by the Schiff plasmal reaction, when the Sudan III method shows little of lipoid reaction.

The question of the glyco-phosphatase relationship is most thoroughly treated by Wislocki and Dempsey, who present a rather complete argument for the utilization of phosphatase in the deposition of glycogen by dephosphorylation of hexosephosphate, which later is transformed by the cell into glycogen. The indirect evidence which they have collected certainly is strongly presumptive of such action. When considered in the light of their findings (Dempsey and Wislocki, 1944) and of the environmental relationships of the human placenta, it takes on an even wider significance. Since, according to them, glycogen in the reproductive system is generally located in larger amounts in regions of low vascularity, they suggest that anaerobic glycolysis may be the source of energy in tissues under limited conditions of aerobiasis. Direct evidence will be presented below to show that the rat embryo under experimental conditions has the capacity to secure oxidizable materials by anaerobic glycolysis.

A finding similar to that suggested by Wislocki and Dempsey has also a foundation in Krehbiel's (1937) observation that the antimesometrial portion of the rat decidua is rich in lipoids, while the mesometrial portion is rich in glycogen. Glycogen disappears from its antimesometrial location by seven and one-half days after the onset of pregnancy, timed from the period of copulation. From this time, the blood vessels of the mesometrial region which have formed a capillary net become sinusoidal, with glycogen completely lacking in the walls of the sinusoids. The entire shift in glycogen location occurs in a relatively short period, circa four days, changing position from the antimesometrial region of the decidua through the central area of the mesometrial region and finally, when located in the basal decidua, disappearing in the region of the ectoplacental cone. At just about this time, the contact between the allantois and the ectoplacental lamina (Duval's (1891) "couche plasmodiale compacte") has resulted in the formation of the definitive placenta and the formation of the chorionic villi, which slightly later extended into the maternal sinusoids.

The endometrial changes of pregnancy reflect, in their morphological variation, the physiological flux of the entire reproductive system. They correlate directly with the events leading to implantation and later growth and development. The distribution of known chemical constituents is not by any means as clear as one might wish, but there are certainly sufficient indications of their relations to give a greater significance to this aspect of development than we have hitherto suspected. Further investigation will undoubtedly reveal many more of these relationships.

THE REACTION OF THE MUCOSA

Implantation in the rat always occurs in the antimesometrial wall of the uterus. When the uterine wall is surgically inverted (Alden, 1945), the implantation site still occurs at the original antimesometrial locus. The greater number of uterine glands is found in the antimesometrial region, and here the mucosa is less dense, undergoing a greater degree of folding in the early preimplantation stages.

The thickening of the stroma during pregnancy is eccentric, being much more marked in the anti-

mesometrial region than in the mesometrial at the time of the initiation of implantation. The change in the appearance of the epithelium is also characterized by the same delay, for the antimesometrial epithelium becomes pseudostratified while that of the mesometrial region is still in a high, columnar form. The intervening lining, particularly that in contact with the implanting embryo, shows a thin, cuboidal type of cell.

The change in the morphology of the stroma and epithelium is not necessarily an effect produced by the embryo, for under various conditions of deciduoma formation it can be observed that all of these characteristics are produced without any embryo being present. The changes can be produced chemically, by injury, or by electrical stimulation (Krehbiel, 1937). The uterine wall is a functionally complete system, as has been shown (Nicholas, 1942a) by its capacity to act as a tissue bed for implanting transplanted eggs. These have been placed in a virgin uterus in a small pocket in which decidua formation had been induced by mechanical means. The eggs implanted in these artificial pockets then developed within induced deciduae which supported the egg through to the 9th or 10th day of pregnancy. The endocrine conditions necessary for further development were lacking, and most of the embryos were resorbed on the 9th or 10th day. The experiment, however, shows that the decidua, usually termed a deciduoma, is a potentially functional structure which can enclose the embryo and in which the embryo can complete a fair stage of its development.

The capillary system of the primary decidua shows the same series of delayed reactions exhibited in the stroma. In the mesometrial aspect of the endometrium, the circulatory system is composed of rather large vessels and extends around to the antimesometrial aspect in a perfectly definite capillary net. The mesometrial aspect, although it has the larger vessels, has fewer capillaries in the early stages of implantation. It is for this reason that the antimesometrial aspect of the endometrium can be regarded as having the greater amount of materials potentially available at this stage to the underlying structures. It is possible that this is the mechanism which is responsible for the time lag in reaction between the antimesometrial and the mesometrial portions of the endometrium.

In the second and third pregnancies, there is always at the base of the mesometrium a placental rest which marks the former embryonic site. There is a pronounced coincidence between the position of this area and the site of the next implantation. While this does not offer any positive proof concerning predestination of placental sites, it does give rather strong evidence that regions of predilection exist.

The circulation of the uterus (Everett, 1935; Nicholas, 1945) maintains a fairly stable pattern. The large arteries and veins are all localized in the mesometrium. There is a slight hyperemia associated with implantation, but the capillaries of the stroma form as a loose net or meshwork without any definable polarity.

It is not until the mesometrial decidua forms that a definite vascular trunk can be recognized. There is a small pit containing a capillary at the lower third of the decidua projecting into the transitional zone (cf. Krehbiel, 1937). This capillary passes around the implantation site and later forms a loop within the endomesometrium, by anastomosing with a similar process from the other side. The implantation vascular loop may be found as early as the 7th day of gestation, but usually is first demonstrable on the 8th day.

The formation of this capillary loop is associated with a change in the decidua. There is a definite reduction of tissue immediately peripheral to the implantation chamber. This is accompanied by a longitudinal arrangement of the stromal cells of this region and the consolidation of capillary elements into larger units, finally resulting in a definite capillary loop. It is at about this stage that glycogen disappears from the antimesometrial decidua (cf. Krehbiel, 1937). The shift in glycogen may be used to express conditions of utilization if we accept Wislocki and Dempsey's (1945) hypothesis, that regions of insufficient vascularity are most apt to accumulate glycogen. The change in glycogen content as found by Krehbiel would then indicate that the embryo originally became implanted in a region of low vascularity, which, with later changes in vascularity, results in glycogen dispersal. The embryo's capacity to utilize metabolites of carbohydrate nature, combined with its ability to secure material from energy sources by anaerobic glycolysis (Boell and Nicholas, 1939a, b, c), all fit admirably with the factors present in the morphological and physiological environment. Since fat has been demonstrated in the early trophoblast, it may well be that the mechanism for changing carbohydrate

into fat may appear in the mammalian embryo with exceeding precocity. Further study of this reaction may show whether there is a real utilization of the so-called uterine milk. It is dubious to postulate that the later carbohydrate mechanisms are present in the unattached blastocyst.

The eggs and blastocysts of many of the mammals have points of marked similarity, as pointed out by Heuser and Streeter (1929), and while they vary in size and some other specific details, the pre-implantation phenomena follow, in general, a similar pattern throughout segmentation and the formation of the morula. The time during which these steps occur varies tremendously in different groups of mammals. A pre-implantation period of 9 days is necessary for the monkey (Heuser and Streeter, 1941), while rats require 5–6 days for the same series of phenomena. In still others there is a long period of delayed implantation, such as in deer (Harvey, 1653) and the marten (Marshall and Enders, 1942).

Harvey was not aware of the phenomenon of delayed implantation and so was led to conjectures that resulted in an entirely erroneous interpretation of his study of deer embryology.

The form whose implantation has been most completely followed is the Rhesus monkey, *Macaca mulatta* (Heuser and Streeter, 1941). The monkey is non-interstitial in its implantation phenomena, in contrast with the rat, which has the interstitial type. The 8-day macaque blastocyst, in one case studied, consisted of about 380 cells, of which 95 ± 10 were polar trophoblastic, and 24 were primary endoderm cells. The 9-day blastocyst had reached its maximum size, and its wall consisted of thin trophoblastic cells which Streeter endowed with special properties of functional and structural adaptation. At the embryonic pole is the region generally referred to as the inner cell mass, which consists of a central mass of cells that goes into the formation of the embryo and an outer layer of cuboidal cells which constitutes a specialized part of the central mass and lies in contact with the surface of the blastocyst. This is interpreted as an early polarization of the blastocyst, and successive stages of development certainly justify this conclusion. Heuser and Streeter have argued against the implantation sites as being predetermined, yet of forty-four cases, forty-one showed central implantation, with twenty-one blastocysts implanted on the anterior wall and twenty on the posterior wall of the uterus; two only were implanted near the lateral border of the uterine cavity, and but one near the entrance of the cervical canal. There would seem to be, on the basis of these data, a region of predilection, if not of absolute predestination.

It will be difficult to determine whether the presence of the epithelial plaque in the macaque is causative in implantation phenomena, or whether it is the direct result. Although the primary site of definitive implantation is not originally indicated by histological changes in the epithelium, it is true, as Heuser and Streeter pointed out, that there is a secondary site in the uterine wall just opposite to the primary site, which is formed without direct contact with the trophoblast of the embryo and only later comes into contact with the abembryonal part of the trophoblast. It could be argued from the implantation statistics that the epithelial plaque was localized as a ring of tissue in the uterus, and that the anterior and posterior parts of that ring possess the lowest threshold for implantation stimuli. Whichever is stimulated first by the trophoblast would show the initial development, while the region opposite would become the secondary site. The exceptional cases and the formation of secondary plaques seem to indicate that other parts of the uterus, even though of higher threshold, can be brought into the reaction and become properly functional regions for the completion of implantation if the egg has not become fastened at the ring. The deduction that the plaque is the result of embryonic reaction and not the cause of the localization of the implantation may be sound, but the reasons stated do not seem adequate to rule out predetermination of the implantation site.

Implantation is hard to explain on the general ground of the adhesiveness of the blastocyst, to which Heuser and Streeter refer. In the rat blastocyst this quality seems to be uniformly distributed. In the monkey, moreover, adhesiveness would have to be discreetly localized, since the primary attachment to the uterine wall is at the margin of the inner cell mass, and later, by a circular extension of this margin, around the node comprising the inner cell mass. Still later this becomes an area covering the node, apposition is completed by the tenth day, and the trophoblast has invaded the uterine stroma.

The uterine reaction during this period is considered to have a rather passive role, and Heuser

and Streeter have emphasized this point. Where the blastocyst touches the uterine epithelium, the epithelium is altered in its appearance. There is an evident disarrangement of the nuclei and "the cytoplasm flows and is taken up by the syncytial surface of the trophoblast. As the cytoplasm diminishes, the bared nuclei clump together and appear to flow towards the engulfing syncytium." Thus, in an otherwise unaltered epithelium, cytolysis occurs at these contact points, and the responsibility for cytolysis must be placed on the pressure and activity of the invading trophoblast.

Wislocki and Streeter (1938) have staged the implantation phenomena in the macaque. Their first stage in placental development is the prelacunar stage, or period of the trophoblastic plate, characterized by the presence of a solid trophoblastic plate which invades and ingests the uterine epithelium in a very localized area. The maternal reaction at this stage is one of epithelial proliferation both of the surface epithelium and of the neck of the uterine glands. This period comprises the "9th day during which implantation of preblastocyst begins, and also the 10th day." Their second stage is that of the trophoblastic lacunae; the third is the villus stage, when the chorionic villi begin to form.

A more detailed description of the prelacunar stage, or period of the trophoblastic plate, is as follows: on the ninth day, a blastocyst showing the beginning of attachment to the endometrium was obtained. The uterine mucosa exhibits no local reaction in the vicinity of the attaching blastocyst; the uterine glands are evenly spaced. Between them there is a uniformly cellular stroma with a layer of columnar cells on the uterine surface; the wall of the blastocyst is apposed to the endometrium. Attachment of the ovum is facilitated by deflation of the blastocyst which flattens the trophoblastic surface against the maternal wall. The trophoblast, to one side of the inner cell mass, is thickened and penetrates the columnar epithelium of the endometrium; it has scarcely invaded more than one-fourth to one-half of the thickness of the layer of trophoblast, which can be designated as the beginning syncytium. Moreover, a change is already occurring in the maternal epithelium at the point of contact. The cells are cytolyzed, the nuclei clumped together and evidencing beginning degeneration. Serial sections of this blastocyst reveal five separate spots or points of beginning invasion of the uterine epithelium. Reconstruction of the blastocyst indicates, moreover, that the first syncytial differentiation occurs in coronal form on the surface of the blastocyst encircling the embryonic pole. At the outset the trophoblast immediately over the embryonic mass takes a less active part, but a day or so later this difference disappears. In addition to the minute points at which the trophoblast has penetrated the epithelium, there is no other sign of local change in the maternal tissue.

The above description, which closely follows that presented by Wislocki and Streeter describing the blastocyst of the 9th day, shows the conditions which are found in the uterus, in the uterine epithelium, and in the trophoblast of the embryonic blastocyst. The facts that the maternal epithelium shows cytolysis and that the nuclei are clumped together certainly warrant the interpretation of a beginning degeneration. However, this same reaction is susceptible to an alternative interpretation. The uterine epithelium at this stage of development is losing its former relationships as a surface structure, due to the presence of the embryo. This may change the whole physiology of the superficial cells of that region and may alter also the medium which usually bathes the surface and the secretions which might be liberated from the cells of the uterine epithelium. The function of the epithelial cells has been disarranged, and they may be temporarily reorganizing but unable to adapt themselves to the competition with the rapidly growing embryonic trophoblast. I would suggest, then, that the trophoblast, not only because it is competitively invasive, but also simply because it is in contact with what is normally an outside layer of cells, may indirectly be causing the effects which are noted above.

Wislocki and Dempsey (1945) have suggested that there may be an oedema caused in the underlying tissues which results in some of the changes that are noted in the uterine epithelium. Their suggestion, however, is based upon older stages than those which are dealt with here and cannot be the effective principle at the beginning of implantation, when only a slight margin of contact is maintained between the blastocyst and the uterine epithelium. It is apparent that embryonic growth dominates in creating a situation in which the uterine mucosa is not able to compete. This, however, should not be interpreted as meaning that the trophoblast is not affected by the uterine epithelium. This is characteristically shown in

that the trophoblast itself differs structurally in regions where it is in contact with and in those where it is free from the mucosa, and conversely that the uterine epithelium shows active proliferation at the region of attachment and around the neck of the uterine glands.

IMPLANTATION AND POLARIZATION

Concerning the polarization of the rat embryo there is practically no information. Huber (1915) stated that at the time just before the germ layers are forming (early 9-day embryos) there is a definite positional orientation of the embryo. During implantation the inner cell mass of the morula is always located toward the mesometrial aspect of the slit-like lumen. The implantation cone is always antimesometrial and is composed of the blastocyst wall opposite the inner cell mass. Nicholas (1945) has found that exceedingly rarely this condition is reversed and that when such reversals do occur, the embryo fails to implant adequately and is resorbed at about the time of the 7th day vascular extravasation. The morula has undergone a pseudo-implantation, the decidua is normal in formation, but the implantation phenomena are not adequate to support the embryo. During resorption the embryo forms a compact core within the decidua, candle-like in appearance and consisting of elements similar in form to the connective tissue-like cells described by Defrise (1933).

On the basis of evidence at hand, it seems likely that there is a considerable amount of regimentation in the development of the rat imposed directly upon it by the maternal physiology. While the evidence is not yet clear concerning rigidity of placental site, it is certain that the predilection towards certain uterine regions as manifested by the relation of present pregnancies to previous ones is great. Sensitization of the uterus by the hypophyseal-ovarian mechanism is a matter of timing in which the embryo has considerable leeway. When it begins its implantation, however, its orientation must be quite precise, and once in the vise of the decidua there is little chance for the embryo to do any mass adjustment.

OPERATIVE ATTACK UPON PROBLEMS OF DEVELOPMENT

The first big problem dealt with the regenerative possibilities within the mammalian fetal nervous system (Hooker and Nicholas, 1930). The background of this work had been so admirably studied on non-mammalian forms by Hooker (1915, 1917, 1925) and a definite answer was so imperative for carrying forward work on the regeneration of mammalian nerve cells, that this seemed a logical plan for a first attack.

Cauterization and transection of the cord were satisfactorily accomplished in rat fetuses during the last third of gestation, and the results of experiments performed in that period are indisputably clear. There is not the slightest capacity for regeneration in these stages under the condition of our experiments (cf. Gerard and Grinker, 1931; Sugar and Gerard, 1940). In the 1940 results of Sugar and Gerard partial regeneration was obtained, and fibers cross the region of incision when the operation is performed by an incision after cord extension—a condition which is impossible at present with the embryo.

Experiments on younger stages (cf. also Sugar and Gerard, 1940) became increasingly precarious, and although in one or two cases there were indications of proliferation and partial regeneration effects, the evidence was too scanty to allow a definite statement of general significance. The interference with normal vascular supply and the overgrowth of the mammalian embryonic membranes after operation were two of the factors which made the results far from conclusive.

Other studies involving the reaction of the central nervous system have been performed by Hall and Schneiderhan (1945) in rats, and by Barron (1945) in sheep. Both of these studies show that hypoplasia of the ganglia and the cord results from the amputation of the limb during fetal life. This reaction brings the nervous system of the mammal under the same general rule that obtains in the chick (Hamburger, 1934) and the amphibian (Detwiler, 1924).

POTENTIALITIES OF EMBRYO DEVELOPMENT AFTER TRANSPLANTATION

It was obvious from the results obtained during the experiments upon the nervous system that the limits of technical approach to this problem in utero were being reached. The amount of tissue interference and the dependence of the embryo upon a normal vascular condition made it clear that some other method must be applied. Accordingly, investigations were begun along two distinct lines in which certain variables were imposed upon the embryo. The first changed the

surface and physical environment of egg cylinders 8 to 14 days of age. The second imposed morphological and positional changes, all of which involved physiological adaptations.

The length of survival of the 8- and 9-day embryos was tested by removing them from the uterus and placing them in different concentrations of saline solutions at varying temperatures and then fixing and staining them to see to what degree the cellular constituents had undergone histolytic changes. The tolerance for salt concentration was higher than expected, so that it was assumed that a normal saline concentration of 0.8 per cent, as found in Ringer's, Locke's, Tyrode's, or physiological saline, was adequate for testing temperature effects. Embryos divested of deciduae survived 6 hours' exposure at 37.5° C., and 18 hours at 20° C. without cytolysis. The deduction was obvious that the time necessary for handling the embryos during operative procedures did not alter appreciably the viability of the tissues. Embryos from which the deciduae had not been removed cytolyzed in about two hours at body temperatures.

The temperature effect was further tested by transposing one-half of the uterus containing 8- to 9-day embryos from its abdominal location to a subcutaneous one. The young were born alive at the same time as those in the non-transposed abdominal uterus. There is a difference in temperature of about 2° C. between the two loci. In another series, the uterus was transposed before copulation, and the course of pregnancy ran regularly to term as in the 8- to 9-day embryos. Another study exposed the embryos to test under varying conditions of transplantation. Many sites were explored, the more successful being the mammary gland (Nicholas, 1934), the caecum, and under the kidney capsule. In addition to these, the embryos were studied after transplantation to the chick chorioallantois (Nicholas and Rudnick, 1933).

From the various sites investigated it was ascertained (1) that the tissues remained viable, capable of proliferation, with the capacity of forming identifiable tissues and structures at a normal or even sometimes accelerated rate; (2) that while histogenesis and organogenesis were fairly constant, complete morphogenesis occurs in only a small proportion of the cases, namely, those transplanted into the body cavity upon a mesentery and into a pocket adjacent to the caecum.

EXPLANTATION OF EMBRYOS

Explantation experiments have been carried through by Brachet (1913), using the blastocyst of the rabbit. He secured development and differentiation with this form. One must, however, start with a comparatively late stage after the blastocyst is fairly completely formed, in order to have development, even in the rabbit, of organized embryonic material. Brachet, unfortunately, was not able to carry his studies to their logical conclusion, but he certainly pointed the way for experimental studies of the developing blastoderm in the rabbit. More recently Waddington and Waterman (1933) have used an experimental method founded upon Brachet's work (cf. Törö, 1938). In this they claim to have established the action of organization centers or organizers for both the rabbit and the chick. In the light of unpublished work by M. V. Edds, it seems unlikely that the interpretation which Waddington and Waterman placed upon their material is adequate to explain what happens in general in mammals. There is a strong trend today towards the belief that if an organization center occurs in mammals, it does so considerably earlier than in the amphibian or in the chick (Holmdahl, 1942).

Explants of rat embryos at the egg cylinder stage were carried out (Nicholas and Rudnick, 1938) with the usual tissue-culture technique, employing chick plasma or rat plasma and rat embryo extract as media. These explants showed very quickly that their growth and development were retarded, and while they could be studied for a brief period of 12 to 20 hours, during which they had a comparatively normal and regular development, the ultimate fate of such an embryo was degeneration (cf. Jolly and Fèrester-Tadié, 1936; and Jolly and Lieure, 1936, 1937). Maintenance effects were found in the ensuing period; in the best cases growth was obtained for 36 hours and maintained for 12 hours more. If, however, the organism is removed from the culture and washed in sterile Ringer's solution with fresh embryonic extracts added every 24 hours, embryos can be kept alive for 96 hours, although growth and differentiation occur only at a slow rate during the last 24-hour period. The experiments with the explanted embryos show rather definitely that processes of differentiation and growth can be separated by explantation of an embryo in tissue cultures, and that the differentiation of embryonic structures in normal relationships to each other

can be successfully completed. The method also offers an opportunity for the study of obscure processes, such as the turning of the embryo, the initiation of circulation, and other reactions of the embryo during critical stages of its development.

The explantation experiments (both our own studies and those of Jolly et al.) have shown that rat embryos possess the capacity for limited development during certain critical stages. It has long been recognized that whenever embryonic extracts, serum, and other animal fluids are used as tissue culture media, variables exist which prevent reliable repetition of the experiments. Plasma obtained on successive days from the same animal may give entirely different results. Plasma stored in an ice-box may undergo changes which are sufficient to alter growth reactions of biological materials, even when used within 24 hours after the initial bleeding.

So much attention has been paid to the study of the media necessary for tissue proliferation that little effort has been expended upon the physiological readjustments which occur in the tissue. If growth is not obtained, various hypothetical entities are used to explain the negative results. Whatever the factors may be, it is clear that when fluids of insufficiently known composition are used, we have been exceedingly fortunate to be able to repeat any experiment. Until the reactions of specific cells to the medium in which they are cultured are known, the answers to many problems must be fragmentary. It is possible that the cells of one germ layer may be stimulated to more rapid development than those of another even in an inorganic environment. This last possibility has been most recently suggested by Holtfreter (1945). He exposed the outer covering layer of *Amblystoma* eggs to a rather hypertonic salt solution and secured an induction of neural structures in presumptive ectoderm, resulting presumably from contact with the hypertonic fluid.

EXPLANTATION OF EGGS

Although the rabbit egg proved capable of cultivation and was used in the photographic studies of Lewis and Gregory (1929), the mouse and rat have not proved nearly so amenable to this type of treatment. Defrise (1933) studied a number of media and their effect upon rat eggs. He was unable to secure more than one or two normal cell divisions in any of the culture materials used. However, in a morula he was able to carry differentiation to a greater extent than hitherto, but instead of organizing embryonic form as one might expect, all of the cells gave rise to loose connective tissue-like elements, somewhat resembling extra-embryonic membranes rather than embryonic tissues.

EXPLANTS IN CIRCULATING MEDIA

The idea of studying tissues in a circulating fluid is not new. Perfusion experiments such as those run with the aid of the Lindbergh apparatus (1935) have shown conclusively that it is possible to keep tissues and organs alive over long periods of time with the aid of simple transfusions. Under such conditions synthetic media can be used and can support growth where usual culture conditions would allow degeneration and decay. In the first tests that were made upon rat embryos in a circulating medium, the hydrogen-ion concentrations of the medium were determined. There was a considerable embryonic tolerance to variations in hydrogen-ion concentration. The embryos themselves at any particular stage seem to be able to accommodate themselves to a wide range of pH, providing the change is gradual. Embryos have been grown successfully at pH's ranging from 5.8 to 8.5. This shows the range of accommodation in the embryo, but tells nothing about the conditions under which it normally develops.

The experiments in the circulator showed several facts about the developmental potentiality of the rat. In the first place, rat embryos grew and developed more regularly in a circulating medium than in a still culture. They possessed the capacity to regulate to variations in temperature and pressure as well as to hydrogen-ion concentration. Early growth, as indicated by mass enlargement of the embryo and distension in the yolk-sac epithelium, can occur under varying conditions. Advances in differentiation, as shown by a histological study of the organs, indicate that morphogenesis can proceed with uniform rate and regularity. This experimental approach has now reached a state in which the reaction of the embryo to small units of biological or chemical substances can be studied in detail.

TRANSPLANTATION OF RAT EGGS

The above experiments were all performed upon 8- and 9-day egg cylinders. It was thought possible that there might be other clues to the viability and differentiation of embryonic parts if develop-

ment ensued after experimental manipulation of the egg. It was for this reason that the egg was studied by transplantation to various loci upon the mesenteries within the abdomen. Here, e.g., upon the omentum, the egg degenerates very quickly. In order to circumvent this reaction, which was thought to be due to the exposure of the serous epithelium at the time of transplantation, the eggs were permitted to be transported through the fallopian tube, which was severed from the uterus shortly after copulation. The eggs then dropped into the body cavity and implanted upon the mesometrium, lodging in the lower portion of the abdomen in close contact with the mesentery of the uterus. The mesometrium accommodated the embryo, which grew to full size at term. The fetuses were fully developed and regular in organization. The organism adapts physiologically to the new type of environment. This experiment was repeated, and its was found that abdominal pregnancy could be obtained in about 5 per cent of the cases, the rest apparently resorbing.

Transplantations under the kidney capsule (Nicholas, 1942b) have been successful. When several eggs are placed under the capsule, there is a generalized fusion of the differentiating parts during the course of development. There is never a regular embryonic organization, but the tissues of which the graft is composed are completely differentiated histologically. They have their characteristic structure, and the mass of materials is far in excess of what one would expect for the time during which differentiation has occurred. The site does not, however, offer any opportunity for the study of embryonic organization. The tissues have no normal anatomical relationship to each other, and they develop at an accelerated rate. The giant trophoblast cells are found in large numbers; they are derived from embryonic blastocyst and not from maternal mucosal tissues. This is substantiated by Alden's staining studies.

The next question to be answered was whether the virgin uterus could be induced, at the proper point in the oestrus cycle, to permit the development of eggs transplanted to it (Nicholas, 1942a). Eggs were placed in the uterus after stimulating the vagina with a glass rod. This seems to be an adequate stimulus for the sensitization of the mucosa, and the eggs will implant, occasionally progressing through the blastocyst and into the egg cylinder stage. None develop to term; they have all of the initial reactions of a normally developing egg, but degenerate at about the time the placenta should form as a functional structure.

Eggs, when transplanted into a uterus of pregnancy, seem to maintain their own rate of development. A greater frequency of take is secured when the transplanted eggs are in the same stage as those of the opposite part of the uterus. If, however, eggs of 72 hours are placed in the uterus while the normal eggs are just in the process of ovulation, the birth of fetuses developing from the transplants will occur before the birth of the young of the normal side. Two separate parturitions can be obtained, one in advance of the other, showing that the aging of the embryo has a distinctive effect on parturition responses and that implantation can occur even earlier than usual under these conditions.

Mammalian eggs must not be considered as fragile material. Rat eggs will stand rather harsh treatment. Hall (1935) tested the various parts of the uterus during different stages of oestrus, in order to discover the variations in the normal hydrogen-ion concentration. He was led to this idea by the fact that Huber (1915) had noted that eggs in some fixed preparations, particularly after the use of acid fixatives, lacked the corona radiata and the zona about them. In Hall's experiment, the eggs were removed from a watch-glass containing the tubal debris and washed in warm mammalian Ringer's solution. They were later transferred in a small drop of this fluid to a clean watch-glass, to which was added, while the eggs were under observation, calcium-free Ringer's solution which had been acidified with HCl to a 0.0002M concentration. The first visible effects of the solution were the swelling of the zona, which with a further addition of fluid became flaccid and sticky and adhered so firmly to the glass that it could be stretched by directing a jet of fluid against the egg. At that time the reaction was reversible, and the zona could be restored, if the reaction had not gone too far and if the fluids acting upon the zona were replaced with neutral Ringer's solution. The time required for removal is short in more acid solutions (10–15 minutes), longer in less acid, generally a matter of hours.

As soon as the zona was removed, the naked blastomeres were placed in Ringer's solution buffered to pH 7 and Ca-free in order to prevent the blastomeres from sticking to the glass of the dish. The blastomeres were then separated, either by directing against them a vigorous jet of fluid from

the capillary pipette or by cutting them apart with either a fine glass needle, or with the end of a fine eyelash. The jet method of separation is preferable, for both blastomeres can then be saved for later transplantation. The blastomeres used in the earlier experiments were secured after cutting or pulling apart the two elements (Nicholas and Hall, 1942). One-half of the egg is sufficient to initiate the development in the rat mucosa and to cause the formation of the decidua. Some formed egg cylinders of early embryos. Two blastomeres can be fused, producing a single, total, over-sized fetus. The results show that the rat egg possesses the capacity to satisfy two of the criteria for an equipotential system; each of the two parts of the egg may form a whole embryo which develops further than the cleavage stages, and the fusion of two eggs produces one single individual of large size.

Blandau (1947) reports that the rat uterine mucosa is far more sensitive to implantation phenomena after introduction of glass or paraffin beads than is that of the guinea pig.

DELAYED IMPLANTATION

It has been known for a long while that the implantation time in various mammals can be changed, particularly if there is a suckling litter which is present at the time of the secondary pregnancy. Pincus (1936) has asserted that this is the result of the fact that rats and mice have an oestrus period within 48 hours of parturition in which normal mating and fertilization take place. Enzmann, Saphir, and Pincus (1932) have analyzed all the available data for mice and rats, and find that each suckling young on the average prolongs pregnancy about 21 hours, although time of prolongation varies. Krehbiel (1941) did not confirm this quantitative estimate of the prolongation of pregnancy. According to this author the implantation phenomena are suspended apparently until the progesterone has piled up in sufficient amounts to permit implantation. Enzmann (1935), however, was able to trace the course of the late implanting eggs, and found that the rate of development after implantation is identical with that of the normal embryo. Wislocki and Goodman (1934) injected progesterone for 8 days after mating, without delaying pregnancy. Antuitrin-S and Antuitrine-G injected in fairly large amounts during pregnancy caused no delay, in spite of the fact that they induced ovulation and new corpus luteum formations. Hamlett (1935) held that delayed implantation is due to hypo-secretion of the corpus luteum. This view was founded on his study of the nine-banded armadillo, where the unimplanted vesicle lies free in the uterine lumen from July until November.

EGG RESPIRATION AND GLYCOLYSIS

In the work reviewed above many of the vicissitudes to which a rat embryo may be subjected have been described. The series of explantation experiments exposed the basic fact that there is not enough known about the cellular requirements of the egg to be able to gauge their significance. Information must be secured concerning the energy requisites of the embryo and their utilization. Fortunately, the technical approach to this problem has been worked out by Linderstrøm-Lang (1937) and Boell, Needham, and Rogers (1939). It had previously been applied to similar studies dealing with respiration of sea urchin and amphibian eggs. The apparatus is termed by Boell the Cartesian diver ultramicrorespirometer, and with it the oxygen consumption of 6 to 10 rat eggs having a dry weight of 0.2 gamma can be measured with a fair degree of accuracy (Boell and Nicholas, 1939a, b, c).

The oxygen consumption averages 0.0007 cmm. per egg per hour in 1- and 2-cell stages. This figure increases during the production of 16-cell and morular stages. At the stage when the embryo has implanted and is forming its primary layers (stage 12), the value obtained is 0.01 cubic mm. per hour, while on the 10th day, just before the initiation of the heartbeat (stage 20) respiration has risen to 0.2 cubic mm. per hour.

Carbohydrate probably is easily used as a primary energy source, since maintenance of respiration in vitro is obtained by adding metabolites of that nature. Anaerobic glycolysis must be considered as a definite mechanism by which available materials can be utilized by the egg and embryo. The amount of energy made available to the embryo by this method is at least the equivalent of that demonstrated in vitro through respiratory activity. These experiments have given us a picture of what the egg can do under experimental conditions. The figures and quantities are comparable when the experiments are repeated, showing that the method is reliable and that the figures obtained have a fair degree of accuracy. Other investigations are planned to give more information

on the utilization of these small fractions which are so vital for the beginnings of embryonic history.

In Fig. 1, the results of three different determinations are shown. The curves 1 and 2 were secured from follicular eggs which, in spite of the adhering cells of the follicle constituting the zona, show a distinctly lower O^2 consumption than the material used in obtaining curve 3, which consisted of 25

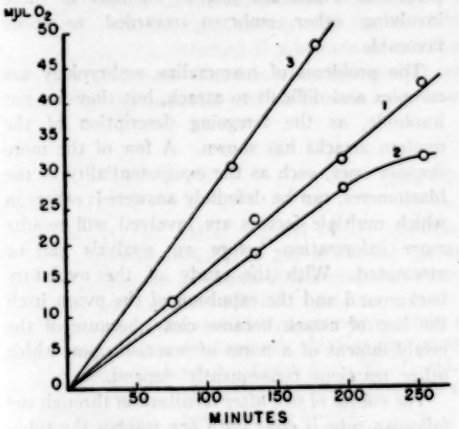

FIG. 1. OXYGEN CONSUMPTION OF RAT EGGS

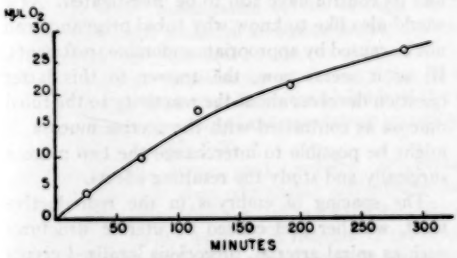

FIG. 2. OXYGEN UTILIZATION BY RAT EGGS

two-celled rat eggs. The follicular eggs were removed from the ovary near the completion of their development, and some of the superficial adnexa was removed. Undoubtedly the thecal and zonal cells remaining contribute to the rather high value obtained for this type of egg. The graphs shown in Figs. 2 and 3 reveal the behavior of the egg with reference to O^2 utilization. In Fig. 2 both the total and rate of consumption are shown plotted against time; whereas Fig. 3 shows the slight increases which occur during the different stages of cleavage. There is an increased O^2 consumption with the increase in the number of cells.

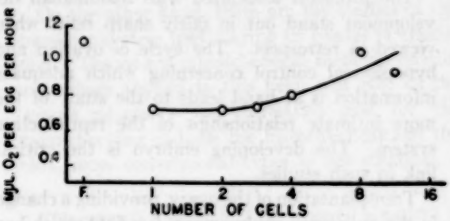

FIG. 3. THE INCREASE IN OXYGEN CONSUMPTION WITH CELL DIVISION

TABLE 1

Respiration of rat eggs

EXPT.	CELL STAGE	NUMBER OF EGGS/ DIVER	TIME OF EXPT.	X_{O_2}	Q'_{O_2}	AVE.
8	Follic.	6	150	23.2	1.45	
39	Follic.	13	256	42.5	*0.77*	1.11
39	1	9	196	27.8	0.94	
37	1	32	35	10.7	0.57	
5	1–2	8	215	19.2	*0.67*	0.72
8	2	11	180	21.5	0.65	
10	2	10	120	14.2	0.71	
12	2	12	60	7.5	0.62	
12	2	12	60	9.2	0.77	
16	2	25	180	48.0	0.64	
17	2	15	115	33.0	1.15	
19	2	15	30	5.8	0.77	
19	2	14	30	4.0	0.58	
37	2	49	35	14.5	1.4	
39	2	13	134	13.2	0.45	
48	2	14	40	8.4	*0.90*	0.72
20	2–4	22	35	9.3	0.73	
50	2–4	27	60	8.6	(0.32)	
53	2–4	23	60	5.4	(*0.23*)	0.73
39	3–4	13	256	12.0	(0.31)	
24	4	15	115	17.2	0.60	
49	4	11	80	15.7	*1.00*	0.80
10	8	2	120	3.9	0.98	
19	8	9	30	7.5	1.70	
54	8	15	30	3	(0.3)	
55	8	17	60	10	*0.51*	1.06
28	8–16	12	110	20.7	*0.44*	0.44
28	Morula	19	120	17.4	0.46	
Total ave.					0.76	
Average without ( )					0.81	

X_{O_2} = Total O_2 consumed.
Q'_{O_2} = O_2 uptake/egg/hour.

The data from which the above graphs were derived are given in Table 1.

CONCLUSION

The problems associated with mammalian development stand out in fairly sharp relief when viewed in retrospect. The cycle of ovarian and hypophyseal control concerning which adequate information is at hand leads to the study of the more intimate relationships of the reproductive system. The developing embryo is the critical link in such studies.

Transplantation of the ovary, providing a change in the gene soma environment, is a field which has received too little attention in the study of any but the most obvious of problems. Robertson's results show clearly that the method for producing functional transplants is at hand and that as applied to his particular problem it can give a critical answer. Its utility in studying hypophyseal factors and the way in which they work during the functional interacting periods of ovulation, implantation, and placentation remain to be worked. It is not beyond reason that the entire timing of the mechanism may be brought under control with studies of this nature.

The uterine mucosa mirrors the endocrine reactions. The intensive histochemical study now in progress indicates the amount of information still available in the study of the endometrium. It itself is a chemical indicator sensitive beyond our previous concepts of biological reaction. The correlation of the changes in the vascular pattern, the changes in both its chemical and morphological constitution, together with those effected by the embryo during preimplantation and implantation stages, cannot do otherwise than yield a more nearly accurate view of what is happening in both the reproductive and the embryonic systems.

The problem of implantation seems at present even more confused than usual, for no broad pattern of generalization is possible, since individual species vary so widely in both action and response. There is evidence that some of the apparent complexities may be resolved; but the present outlook in this field is toward the discovery of more variants rather than of a more homogeneous pattern of reaction. This is particularly evident in both the histochemical and the enzyme studies.

Sufficient work has already been completed to show the applicability of the methods of experimentation to the problems of mammalian development. The surgical techniques are more complex than in amphibian embryology, but the approach is essentially direct. Transplantation is a particularly admirable method for uncovering some of the potentialities and potencies of whole organs and of embryonic materials. Its import for the continuing evaluation of endocrine relations is obvious. The reactions of the uterus relative to both the ovary and the embryo can be investigated by experiments which are just as rigorous as those involving other embryos regarded as more favorable.

The problems of mammalian embryology are complex and difficult to attack, but they are not insoluble, as the foregoing description of the modern attacks has shown. A few of the more decisive ones, such as the equipotentiality of the blastomeres, can be definitely answered; others in which multiple factors are involved will require more information before an analysis can be attempted. With the study of the ovulatory background and the expulsion of the ovum itself the line of attack became clear, because of the establishment of a norm of reaction upon which other reactions consequently depend.

The course of ova after fertilization through the fallopian tube is clear until one reaches the tubo-uterine junction. The mechanism of this valve and its control have still to be investigated. One would also like to know why tubal pregnancy can not be caused by appropriate endocrine treatments. If, as it seems now, the answer to this latter question devolves about the reactivity to the tubal mucosa as contrasted with the uterine mucosa, it might be possible to interchange the two mucosa surgically and study the resulting effects.

The spacing of embryos in the reproductive tract, whether prelocalized by uterine structures such as spiral arteries, precocious localized crypts or presensitized mucosal areas—all these await future answers. Correlated with this is the whole problem of implantation and plantation, during which embryonic horizons widen and the limiting uterine areas expand. The functional onset of the various types of permeable structures and the varying degree of their relationship to the embryo form as yet a conceptual series of inferences which must be analyzed before we can come to a factual basis for the factors underlying the nutrition of the embryo.

These are just a few of the problems which stand out in the experimental approach to an important

system, one from which similar functional components can be compared with others of essentially the same nature.

The onset of the chemical and physical investigation of such complex relationships has been generally invoked but seldom worked. The reasons are clear, for the systems are so transient and labile that we have in few cases been able to stop all parts of the mechanism at one time in order to obtain light on any one factor. This effect must be obtained if adequate correlations are to be made. The histochemical studies correlating the mucosal and embryonic membrane content are studies which come close to fitting this criterion.

On the other hand, there are the studies of the transient system itself during its phases of transition. The newer microchemical methods now in use, where applied to this field, will give us the factors necessary for correlation and for the cross-checking of both the histochemical and the older more conventional types of histoanalysis.

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MAUPERTUIS AND THE BEGINNINGS OF GENETICS

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INTRODUCTION

THE middle of the eighteenth century constitutes one of the greatest epochs in the development of natural science. Newton's physics had finished the creation of a new Heaven and a new Earth. In the biological realm, the stimulus given by Linnaeus, through his *Systema Naturae* in 1735 and his introduction of binomial classification in 1753, to the taxonomic survey of plants and animals was immense. The Abbé Abraham Trembley, by describing the little *Hydra* and its amazing powers of budding and regeneration, awakened the widest interest among educated circles in this supposed plant-animal, which was a living witness that, as Leibnitz had said, "All advances by degrees in Nature, and nothing by leaps." Naturalists of the time were imbued with this philosophy of Nature. Indeed, "next to the word 'Nature,' 'the great Chain of Being' was the sacred phrase of the eighteenth century, playing a part somewhat analogous to that of the blessed word 'evolution' in the late nineteenth" (Lovejoy, 1936, p. 184).

Among the natural philosophers of the time was the then renowned head of Frederick the Great's Academy of Sciences in Berlin. This man, whose great contemporary reputation has been almost completely eclipsed because of the vicious satirical attacks made upon it by Voltaire, was Pierre Louis Moreau de Maupertuis (Fig. 1), a many-sided French genius whose human failings proved all too vulnerable to the rapier-like thrusts of his adversary's sarcasm. Yet Maupertuis was recognized as the first in France to appreciate the validity and importance of Newton's formulation of the laws of gravitation; and, indeed, it was through Maupertuis that Voltaire first became convinced of their truth. When thirty years of age, in 1728, the year of Newton's death, Maupertuis went to London. Here he became a member of the Royal Society and an ardent supporter of Newton's theory of gravitation, at a time when it was still violently opposed in France by the adherents of Cartesian vortices. D'Alembert, in his introduction to the *Encyclopedia* (1778), praised Maupertuis' courage in being the first to declare himself openly an adherent of Newton (in the *Discours sur la figure des astres*, 1732). In that same year Voltaire—more and more interested in scientific pursuits by the fascinating Mme. du Châtelet, who was soon to undertake to translate Newton's work into French—wrote to Maupertuis, asking him in flattering terms for his judgment upon Newton's theory. To Voltaire's conversion, which followed, we owe his own work on the subject, by far his most serious scientific production.

Four years later (1736) we find Maupertuis heading an expedition to Lapland to demonstrate the flattening of the earth toward the poles, a phenomenon predicted on Newtonian theory. This was to be done by accurately measuring a degree of longitude at different latitudes. Upon his return from Lapland—accompanied by a young Lap maiden of whom he had become enamoured—Maupertuis was addressed by Voltaire in these flattering words (letter of 19th Jan., 1741): "M. Algarotti is count; but you—you are marquis of the arctic circle, and you have won for yourself one degree of the meridian in France and one in Lapland. Your name covers a good part of the globe. I find you really a very great seigneur. Remember me in your glory." It was, in fact, on Voltaire's recommendation that, in 1740, Maupertuis was invited by Frederick the Great to come to Berlin as head of the reorganized Academy of Sciences (Brunet, 1929).

Maupertuis himself felt that his work as a champion of Newton on the Continent was no great personal glory, and he therefore laid great weight on his discovery of the principle of least action, which is only too often credited to some one of the three mathematicians, Euler, Lagrange, and Hamilton, who further developed it. This is indeed one of the very greatest generalizations in the realm of physical science, although not fully appreciated until the advent of quantum mechanics in the present century (Fee, 1941). It was in

connection with this discovery that Maupertuis became the target of Voltaire's merciless and devastating satire, and their friendship of twenty years was broken. This came about in the following way. Samuel Koenig, a friend and former fellow-student of Maupertuis, followed Maupertuis' publication of the principle of least action in 1746 by two charges: first, that it was based on erroneous conceptions; and second, that it was not original, but had been proposed by Leibnitz in a letter some time before his death. Koenig submitted to the Berlin Academy a copy of a fragment of the letter, in substantiation, and later sent Maupertuis a complete copy. Maupertuis pointed out some disagreement between the two copies, and demanded that the original letter be produced; but

Le Globe mal connu qu'il a sçu mesurer,
Devient un Monument où sa gloire se fonde:
Son sort est de fixer la figure du Monde,
De lui plaire, et de l'éclairer.
par Mr de Voltaire

FIG. 1. PORTRAIT OF MAUPERTUIS

The flattering words of Voltaire's verse beneath the picture may be contrasted with Voltaire's sarcastic later reference to the scientist who had himself painted in a fur bonnet.

this could not be done. The owner, it seems, had lost his head, in a literal sense, some time previously, and the letter could not be traced. After due deliberation, the Berlin Academy by unanimous vote, Maupertuis abstaining, declared Koenig's letter to be a fabrication; and he was expelled from the Academy. This was too much for Voltaire, ever eager to defend injured innocence against those in high places. (Or was it, as some have said, that Maupertuis had refused Voltaire a requested favor?)

The world has heard largely Voltaire's side of this famous dispute, and a sober reappraisal, such as Fee has made, has been long overdue. Koenig seems to have been a sincere, well-meaning man; but one cannot credit him with very good judgment in attacking Maupertuis upon such flimsy evidence; and nothing but a smile seems appropriate for the logic that led him in one breath to claim first that the discovery was based on error and was without worth, and then that it had already been made by another. It seems quite probable that Leibnitz did arrive at the principle of least action, and he may have written such a letter as Koenig claimed. But at any rate he did not publish it, and Maupertuis was well within his rights in demanding that the original letter be produced. No unpublished discovery can take from Maupertuis that recognition due his priority in publication. Nor was his clear formulation of the law at all, as some have claimed, "a generalization vaguely conceived and ill formulated" (Lovejoy, 1904) or merely "proposed in metaphysical shape" (Pledge, 1947). It was far in advance of the understanding it was to receive during the next century and a half, and Maupertuis had worked out specifically its applications to both inelastic and elastic impact and to the principle of the lever (cf. Fee, 1941). To Voltaire, however, the principle of least action seemed so much nonsense, and Maupertuis a vain man using his prestige and position to suppress criticism and to salve his injured pride.

In 1752 Maupertuis published his *Lettres* and the *Lettre sur le Progrès des Sciences*, a series of suggestions for systematic experimentation and investigation along many lines. These ideas must strike us today as, in the main, extraordinarily well conceived and only too far ahead of their times. The comments of Maupertuis on the nature of the chemical elements, for example, and the possibility yet impracticability of their transmutation, sound far more like the physical science of the twentieth century than like that of the eighteenth. But to Voltaire the *Lettres* supplied fresh evidence of Maupertuis' vanity and incompetence, and he burst forth in the *Diatribe du Docteur Akakia* (Voltaire, 1752a). This was a prime example of that gift which led Macaulay to say: "Of all the intellectual weapons which have ever been wielded by man, the most terrible was the mockery of Voltaire." Maupertuis had suggested that doctors ought not to be paid when they failed to heal, so Voltaire chose a physician as the voice of his irony: "What do you think a man would say, I pray you, who had, for example, 1200 ducats pension for having talked of mathematics and metaphysics, for having dissected a couple of toads, and for having had himself painted in a fur bonnet, if the treasurer should come to him with this language: 'Monsieur, there is a deduction of 100 ducats for your having written that stars are made like windmills; 100 ducats more for having written that a comet will come to steal away our moon and carry its attacks to the sun itself; 100 ducats more for having imagined that comets all of gold and diamond will fall on the earth; you are taxed 300 ducats for having affirmed that babes are formed by attraction in the abdomen of the mother, that the left eye attracts the right leg, etc.? One cannot deduct less than 400 ducats for having imagined understanding the nature of the soul by means of opium and by dissecting the heads of giants, etc., etc.'" (Voltaire, 1752a, *Oeuvres*, v. 23, p. 562). Some of this is rank misinterpretation. Most of it merely shows that Voltaire was not gifted with scientific prevision. But it had its effect. Frederick, having in private laughed at Voltaire's sallies, in public supported the head of his Academy. Voltaire had to retire to France; but the reputation of Maupertuis never recovered from the flood of unmerciful, unscrupulous, and myopic ridicule which Voltaire continued to vent even after the death of Maupertuis in 1759.

In the same year as the *Diatribe du Docteur Akakia* there also appeared Voltaire's famous satire on the scientists and philosophers of his acquaintance, entitled *Micromégas* (1752b). This, too, was partly directed at Maupertuis. It was his expedition to Lapland that the giant Saturnian and the super-giant Sirian were supposed to have discovered and conversed with, and Maupertuis and his little Lap maiden were the butt of Vol-

taire's nastiest witticisms. These are hardly relieved by more favorable comments on the follower of Locke, who might possibly be identified as Maupertuis also, since in a letter to the latter in 1734, Voltaire had addressed him as a "disciple of Locke and Newton." But it is more probable that Voltaire was simply thinking of himself.

Actually, in philosophy as in physical science, Maupertuis proved himself a powerful and original thinker, reproached by Voltaire for views the latter was himself later to embrace. As Lovejoy (1904) has pointed out, Maupertuis anticipated the ideas of Beccaria and Bentham, and along with Helvetius represents "the head-waters of the important stream of utilitarian influence which became so broad and sweeping a current through the work of the Benthamites." Maupertuis also considered anew the favorite argument of the eighteenth century for the existence of God—the argument from the apparent Design of Nature—and formulated in terms very like those of Romanes well over a century later a beautifully clear statement of the survival of the fittest:

> "May we not say that, in the fortuitous combination of the productions of Nature, since only those creatures *could* survive in whose organization a certain degree of adaptation was present, there is nothing extraordinary in the fact that such adaptation is actually found in all those species which now exist? Chance, one might say, turned out a vast number of individuals; a small proportion of these were organized in such a manner that the animals' organs could satisfy their needs. A much greater number showed neither adaptation nor order; these last have all perished .... Thus the species which we see today are but a small part of all those that a blind destiny has produced." (*Essaie de Cosmologie*, 1750, pp. 11–12.)

While he did not deny the possibility of ultimate purpose in the universe, Maupertuis thus pointed out that biology has no need of teleological explanations. In this he reminds us of David Hume, his Scotch contemporary, who argued, in similar fashion (1793): "It is in vain ... to insist upon the uses of the parts of animals or vegetables and their curious adjustment to each other. I would fain know how an animal could subsist, unless its parts were so adjusted."

MAUPERTUIS AS EPIGENESIST

Eminent as are these contributions to physical science and to philosophy, they are matched by Maupertuis' contributions to biology. Here again, it was his great misfortune to have been over a century before his time, and consequently to have met with little understanding. His biological ideas may be considered under the three heads of the formation of the individual, the nature of heredity, and the evolution of species, although naturally these are so closely interrelated that the division is largely artificial. Even in his earliest biological essays, "Observations et expériences sur une des espèces de salamandre" (1727), and "Expériences sur les scorpions" (1731), Maupertuis evinced an absorbing interest in reproduction and those problems that it inevitably generates. Having observed both eggs in the ovaries and live young to the number of 54 in the oviducts of single female salamanders, Maupertuis remarked that "these animals appear very suitable for enlightening the mystery of generation." In the study of scorpions the presence of living young (up to 65 in number) within the female again excited his interest.

The prevailing ideas regarding the origin of the individual in Maupertuis' time were those of preformation. William Harvey, in 1651, had plainly declared his conviction, based on the study of the development of the embryo chick, in favor of epigenesis, that is, of the view that the parts of the embryo are formed in succession out of unshaped material; but the application of the microscope to the reinvestigation of the matter, by Malpighi, led to the conclusion that Harvey had been wrong. Malpighi was led astray by his inability to find any but a fairly well developed embryo in freshly laid eggs, not recognizing that the embryo might have begun its development while the egg was descending the oviduct. He therefore came to the conclusion that embryonic development is simply "an unfolding of what was already there, like a Japanese paper flower in water" (Needham, 1931, p. 166). Swammerdam's investigations of insect metamorphosis—in particular, his demonstration that a perfectly formed butterfly is to be found within the chrysalis—seemed convincing demonstrations of a like sort, although the idea was pushed far beyond demonstrable limits. The caterpillar must mask a perfect butterfly, within which there would be eggs containing, ***multum in parvo***, caterpillars, chrysalids, and butterflies of a generation still to come; and so on.

Another notable scientific doctrine was involved in the common acceptance of the preformation theory, the doctrine, namely, of spontaneous

generation. As long as it was believed that living creatures could arise spontaneously from mud, filth, and putrescent matter, either epigenesis or the preformation of germs disseminated throughout nature seemed inescapable, at least for such organisms. The demonstration by Redi, in 1668, that maggots hatch only from flies' eggs, and do not appear in putrefying meat except when the flies have access to it, cleared the way for the encasement (*emboîtement*) theory of preformation.

The predominance of the preformationist doctrine led to heated claims in behalf of the ovum by the followers of Malpighi and Swammerdam, on the one hand, and of the spermatozoa by the disciples of Leeuwenhoek, on the other; since, if the embryo is preformed, it could not logically be preformed in both parents alike. The discovery of the mammalian egg (or, in reality, of the ovarian follicle) by Regnier de Graaf, in 1672, was a great victory for the ovists, who claimed that the spermatic animalcules possessed only the function of stirring and mixing the two seminal fluids. The animalculists countered with purported observations of homunculi within the heads of the spermatozoa. But this is not the place to trace the exaggerated and frequently ridiculous claims and counterclaims of these two schools of thought. Suffice it to say that by 1740 there remained very few epigenesists indeed, and the encasement theory of preformation prevailed almost universally.

In 1745 a small anonymous volume appeared from the press entitled *Venus Physique, contenant deux dissertations, l'une sur l'origine des Hommes et des Animaux: et l'autre sur l'origine des Noirs.* (The second part had already been printed in the preceding year.) This book was written in a popular style for gentlemen and ladies of the court. The author, who later turned out to be Maupertuis, dared to adopt the discredited epigenetic theory of development. He was led to this by a consideration of the plain facts of biparental heredity, which had been pointed out by Aristotle and again by Harvey, but which the ovists and animalculists attempted to explain away. According to them, heredity might be regarded as a spiritual essence, transferrable in the seminal fluids, and impressing itself upon the preformed embryo provided by one or the other of the parents. This essentially vitalistic idea was abhorrent to Maupertuis. A mathematician trained in Cartesian views, an early convert to Newton's teachings, Maupertuis belies the remark made by Driesch that all epigenesists were vitalists, for Maupertuis was a consistent mechanist. In criticizing the views of the preformationists, Maupertuis would have nothing to do with essences and spiritual "virtues." He argued against the possibility that maternal impressions can affect the foetus, and to him biparental heredity of necessity implied *corporeal* contributions from each of the two parents.

INVESTIGATION OF POLYDACTYLY

One may well wonder what led Maupertuis to these views. The answer is sufficiently clear. He had already, prior to 1745, conducted a careful study in human genetics that is matched by only one other of its time. Shortly after coming to Berlin, Maupertuis must have heard of a polydactylous family which excited his interest, for the investigation had evidently been completed some time before the *Venus Physique* was written, and from the internal evidence seems to have been the main directive to the thoughts and arguments presented in that book. When it is remembered that this was Maupertuis' first extensive venture into biological investigation, that the collection of human pedigrees was a novel enterprise, and that even in the present century the necessity of making a complete record of all normal as well as all abnormal members of the family has frequently been neglected, one can only marvel at his perspicacity. Maupertuis described his study of this hereditary trait no less than three separate times, in the *Venus Physique*, in the *Système de la Nature*, and in the *Lettres*. It is in the latter (Letter XIV) that we find the fullest account, which follows:

"A great physician proposes in a useful and inquiring work (L'art de faire éclorre des oiseaux domestique, par M. de Réaumur, t. II, mém. 4) to perform some experiments on this question [of biparental inheritance]. In the race (*genre*) of fowls it is not rare to see types (*races*) which bear five toes on each foot; it is hardly more to see those which are born without rumps. M. de Réaumur proposes to mate a hen with five toes with a four-toed cock, a four-toed hen with a five-toed cock; to do the same experiment with the rumpless cocks and hens: and [he] regards these experiments as able to decide whether the foetus is the product solely of the father, solely of the mother, or of the one and the other together.

"I am surprised that that skilful naturalist, who has without doubt carried out these experiments, does not inform us of the result. But an experiment surer and more decisive has already been entirely completed. That peculiarity of the supernumerary digits is found

in the human species, extends to entire breeds (*races*); and there one sees that it is equally transmitted by the fathers and by the mothers.

"*Jacob Ruhe*, surgeon of Berlin, is one of these types. Born with six digits on each hand and each foot, he inherited this peculiarity from his mother *Elisabeth Ruhen*, who inherited it from her mother *Elisabeth Horstmann*, of Rostock. Elisabeth Ruhen transmitted it to four children of eight she had by Jean Christian Ruhe, who had nothing extraordinary about his feet or hands. Jacob Ruhe, one of these six-digited children, espoused, at Dantzig in 1733, Sophie Louise de Thüngen, who had no extraordinary trait: he had by her six children; two boys were six-digited. One of hem, *Jacob Ernest*, had six digits on the left foot and five on the right: he had on the right hand a sixth finger, which was amputated; on the left he had in the place of the sixth digit only a stump."

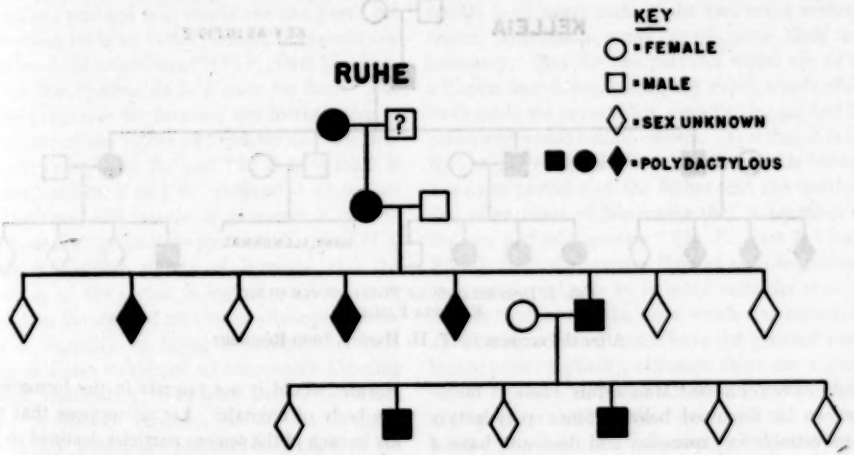

FIG. 2. INHERITANCE OF POLYDACTYLY IN THE RUHE FAMILY
After the account by Maupertuis.

The pedigree is diagrammed conventionally in Fig. 2.

"One sees from this genealogy, which I have followed with exactitude, that polydactyly (*sex-digitisme*) is transmitted equally by the father and by the mother: one sees that it is altered through the mating with five-digited persons. Through these repeated matings it must probably disappear (*s'éteindre*); and must be perpetuated through matings in which it is carried in common by both sexes."

It is truly astonishing to discover that in that very book by Réaumur which served as inspiration to Maupertuis (*L'art de faire éclorre les oiseaux domestiques*), there is said to be an account of the inheritance of human polydactyly that is as circumstantial and complete as that of the Ruhe family. This well-known pedigree was cited in full by T. H. Huxley in his essay of April, 1860, entitled "[Darwin on] the Origin of Species," and the following account is drawn from that source: "A Maltese couple, named Kelleia, whose hands and feet were constructed upon the ordinary human model, had born to them a son, Gratio, who possessed six perfectly moveable fingers on each hand and six toes, not quite so well formed, on each foot." This man married a normal woman and had by her four children. The eldest, Salvator, a boy, had six fingers and six toes; the second, George, had five fingers and toes, but his hands and feet were slightly deformed; the third, André, was normal; the fourth, a girl, Marie, had five fingers and toes, but her thumbs were slightly deformed. All of these children grew up and married normal persons. The eldest had four children, three polydactylous, one normal. The second, George, had three girls, all polydactylous, and a normal son. Two of these girls had six fingers and six toes on each side, but one had but five toes on her left foot. The fourth of Gratio Kelleia's children, his daughter Marie, had one boy with six toes and three normal children. The normal son of Gratio had only normal children. This pedigree is represented in Fig. 3.

How did Maupertuis come to overlook this account by Réaumur, which so closely resembles his own investigation? An examination of Réaumur's rather rare book, in the edition of 1749, has failed to reveal the original account, which is of such length as not to be readily overlooked. For the present the mystery remains unsolved. One circumstance presented by this pedigree would surely have interested Maupertuis extremely had he known of it, for it is one which the Ruhe pedigree lacked. That circumstance was the sudden origin of the polydactylous trait in a man born of two quite normal parents; for this

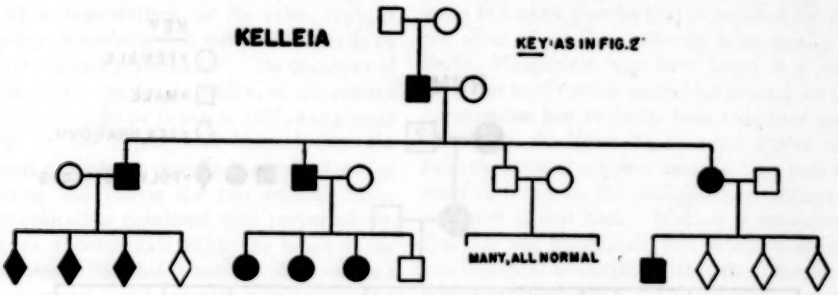

FIG. 3. INHERITANCE OF POLYDACTYLY IN THE KELLEIA FAMILY

After the account by T. H. Huxley, from Réaumur.

would have confirmed Maupertuis' ideas of mutation, to be discussed below. Since polydactyly is so variable in expression and does not have a penetrance of one hundred per cent, this case cannot be accepted today as a certain instance of mutation, inasmuch as it was not established that Gratio Kelleia's ancestry on both sides was free of polydactyly for more than one generation back; but it would have fitted Maupertuis' theory to perfection.

MAUPERTUIS' THEORY OF HEREDITY AND THE ORIGIN OF THE FOETUS

This investigation of polydactyly was the work upon which Maupertuis founded his theory of the formation of the foetus and the nature of heredity, a theory that was more than a century before its time and that brilliantly anticipated the discoveries of Mendel and de Vries. Maupertuis started out with the idea of chemical attraction, that attraction between the particles of different elements which results in the formation of compounds between them. This new chemical concept of Geoffroy and other French chemists of the time was much discussed, and Maupertuis was predisposed to it on account of his early devotion to the concept of gravitational attraction, which seemed to him to be a related phenomenon. As Maupertuis described it, chemical affinities (*rapports*) act so that two substances with a tendency to unite do so; but if a third appears on the scene with a greater affinity for one of the two, it "unites with it while making it take leave of the other" (*V. P.*, Part I, Chap. XVII). Maupertuis next boldly applied these laws of chemistry to living beings. "Why," he asked, "if this force exists in Nature, would it not operate in the formation of the body of animals? Let us suppose that there are in each of the semens particles destined to form the heart, the head, the intestines, the arms, the legs; and these particles may each have a greater uniting power (*rapport d'union*) with that one which, in order to form the animal, has to be its neighbor, than with any other; the foetus will form, and were it yet a thousand times more organized than it is, it would form" (ibid.). Several years later, when Maupertuis, under the pseudonym of Doctor Baumann, wrote the *Système de la Nature* (1751), his ideas regarding these hereditary particles had apparently been influenced by Buffon's theory of organic particles disseminated throughout nature, that theory having been published in the meantime; and Maupertuis attributed to these postulated particles a property "akin to that which in us we term desire, aversion, memory" (*S. N.*, XXXI). Moreover, although in the *Venus Physique* he proposed pangenesis with cautious reservation and only as a hypothesis worthy of investigation, in the *Système de la Nature*, no doubt encouraged in this direction by

Buffon's embracement of the idea, he spoke without reserve. In the *Venus Physique*, the 1746 edition reads simply: "As to the manner whereby there form in the semen of each animal particles analogous to those of that animal, I do not at all examine it here." The same passage in the later version included in the *Oeuvres* (1756) is amplified as follows: "As to the matter of which, in the semen of each animal, particles like that animal are formed, it would be a very bold conjecture, but one perhaps not destitute of all truth, to think that each part furnishes its own germs. Experiment could perhaps clear up this point, if one tried over a long period to mutilate certain animals generation after generation; perhaps one would see the parts cut off diminish little by little; perhaps in the end one would see them annihilated" (*V. P.*, Part II, Chap. V). In the *Système de la Nature* we find: "The elements suitable for forming the foetus swim in the semens of the father and mother animals; but each, extracted from the part like that which it is to form, retains a sort of recollection of its old situation; and will resume it whenever it can, to form in the foetus the same part" (*S. N.*, XXXIII).

This particulate theory of heredity and the formation of the foetus is logically analogous to Mendelian theory, and was far in advance of those ideas of heredity as being determined by indivisible essences subjected to irrevocable blending through intermating, that were current until late in the nineteenth century. If in one direction Maupertuis' hereditary particles look back to the monads of Leibnitz, in the other they look forward to the concept of the genes; and they have really much more in common with the latter than with the former. Of course, Maupertuis confused the hereditary particles with the effects they bring about in embryogenesis, but that was hardly avoidable at a period nearly a century before the formulation of the cell theory. To see that at bottom heredity must depend on a sort of organic, chemical memory, and to attribute this to separable particles that maintain their nature in combination is extraordinary enough. And what can one say of the perspicacity that proposed, as a test of pangenesis, the very experiment that Weismann was to perform nearly 150 years later?

Next to the particulate nature of the hereditary material, the most important of Mendel's principles is that of segregation. The hereditary units, or genes, as we now call them, are present in pairs as a consequence of fertilization, and the members of each pair segregate from one another in the reproductive cells prior to the production of another generation of offspring. This principle, too, was foreshadowed by Maupertuis. However the particles might previously be combined in each one of the parents, the particles from the two semens, he supposed, would unite *separately* in accordance with their affinities and, since corresponding particles from the mother and the father would be most alike, they would unite two by two and exclude other combinations. "One ought not to believe that in the two semens there are only precisely the particles which are needful to form one foetus, or the number of foetuses that the female is to bear: each of the two sexes without doubt furnishes a great many more than are necessary. But the two particles which are to be adjacent once being united, any third, which could have made the same union, would no longer find its place, and would remain useless. It is this, it is by these repeated operations, that the child is formed from the particles of the father and the mother, and often bears visible marks that it partakes of the one and of the other" (*V. P.*, Part I, Chap. XVII). "In the seminal fluid of each individual, the particles suitable for forming traits like those of that individual are the ones which are ordinarily most numerous, and which have the greatest combining power (*affinité*); although there are a great many others for different traits .... The particles analogous to those of the father and the mother being the most numerous, and having the most combining power, will be those which most commonly unite; and they will ordinarily form animals like those from which they are come" (*V. P.*, Part II, Chap. V). This is further clarified by Maupertuis' consideration of hybrids: " ... For as soon as there is a mixing of species, experience teaches us that the child resembles both the one and the other" (*V. P.*, Part II, Chap. V). "If the elements come from animals of different species, but in which there still remains sufficient affinity between the elements; these more attached to the form of the father, those to the form of the mother, will produce hybrid animals" (*S. N.*, XXXVIII). "Finally if the elements come from animals who no longer have between them sufficient analogy, the elements not being able to assume, or not being able to retain a suitable arrangement, generation becomes impossible" (*S. N.*, XXXIX). "One of the most singular phenomena, and one of the most difficult to explain, is the sterility of hybrids.

Experiment has shown that any animal born of the coupling of different species cannot reproduce. Could one not say that in the parts of the hinny and of the mule, the elements having taken a particular arrangement which was neither that which they had had in the ass, nor that which they had had in the mare; when these elements pass into the semens of the hinny and of the mule, the habitude of this last arrangement being most recent, and the habitude of the arrangement which they had had in the ancestors being stronger, because contracted over a greater number of generations, the elements remain in a certain equilibrium, and unite neither in one manner nor in the other?" (*S. N.*, XLIII). To anyone familiar with the causes of hybrid sterility this last paragraph has a startlingly modern ring. For Maupertuis was essentially correct. A set of chromosomes is indeed an arrangement of hereditary elements, and very often in hybrids the chromosomes derived from the two pure species are incapable of normal segregation, because of differences in their genes and because of differences in the arrangements of their genes. The sterile hybrid between the radish and the cabbage furnishes an example. Radish chromosomes cannot pair with cabbage chromosomes. Segregation produces no effective germ cells, for neither an array wholly of radish elements nor one wholly of cabbage elements is likely to recur, and random mixtures of radish and cabbage chromosomes are physiologically ill-assorted.

Mendel is often credited with having discovered genetic dominance, although actually it was known long before his day, having been described by Knight in 1823. Maupertuis also arrived, albeit vaguely, at the idea of dominance. This came about from two considerations. In the first place, as we know today, polydactyly is a dominant trait. For the second, the other genetic character in which Maupertuis became interested, and to which he devoted the second part of the *Venus Physique*, was albinism in negroes, and this is a recessive. Maupertuis was therefore aware that whereas polydactyly descends regularly from affected persons, married to normals, to some but not all of their offspring, albinism, on the other hand, seemed to appear sporadically among negroes, albino negroes being born of parents both of whom were black. Yet Maupertuis was convinced that albinism was hereditary. In Senegal, he reported, it was not rare and whole families were said to be white. Of the famous albino Indians of Panama he discoursed at considerable length and with no little sentimentality. He knew, besides, of similar variants in animals: "The black color is just as hereditary in crows and blackbirds, as it is in Negroes: I have nevertheless seen white blackbirds and white crows a number of times" (*V. P.*, Part II, Chap. IV). Maupertuis was thus faced with the problem of accounting in his theory for the different modes of inheritance. He thus not only recognized that individuals may possess and transmit hereditary particles representing ancestral traits not expressed in those individuals (see above), but concluded: "There could be, on the other hand, arrangements so tenacious that from the first generation they dominate (*l'emporte*) over all the previous arrangements, and efface the habitude of these" (*S. N.*, XLIV).

Had Maupertuis evolved a metaphysical system of heredity and embryogenesis, and done nothing more, he could hardly be ranked above his contemporary biologists. Metaphysical systems, in the eighteenth century, were "a dime a dozen." Georges Hervé (1912), who is almost the sole person to have considered the work of Maupertuis in the light of Mendelian genetics, has said: "His right to figure in a gallery of pre-Mendelian genetics would in that case have been disputable; if he holds a place there, it is because he knew enough to carry his researches into experimental realms." He diligently pursued the collection of further evidence on polydactyly, and with some success, since he could write (1752a, XIV): "I have found in Berlin two six-digited persons, and I have given the genealogy of one. I have not been able to follow with sufficient exactitude the genealogy of the other who is a stranger, and who has hidden himself from me: but he had six-digited children, and I have been assured that this polydactyly has been hereditary in his family for a long time. A scientist illustrious in Germany and Minister to the Duke of Würtemberg, M. de Bulfinger, was of such a family, and born with a sixth finger that his parents had cut off as a monstrosity."

Like Mendel, Maupertuis applied his knowledge of mathematics to genetic investigation, in calculating the probability that polydactyly might be really a sporadic accident and not truly inherited. "But if one," he wrote (1752a, XIV), "wished to regard the continuation of polydactyly as an effect of pure chance, it would be necessary to see what the probability is that this accidental varia-

tion in a first parent would be repeated in his descendants. After a search which I have made in a city which has one hundred thousand inhabitants, I have found two men who had this singularity. Let us suppose, which is difficult, that three others have escaped me; and that in 20,000 men one can reckon on one six-digited: the probability that his son or daughter will not be born with polydactyly at all is 20,000 to 1; and that his son and his grandson will not be six-digited at all is 20,000 x 20,000, or 400,000,000 to 1: finally the probability that this singularity will not continue during three generations would be 8,000,000,000-000 to 1; a number so great that the certainty of the best demonstrated things of physics does not approach these probabilities." This is not only an excellent example of scientific caution, but represents what is without doubt the first application of one of the most important of the principles of the mathematics of probability, that of the probability of coincidence of independent items, to genetics. It was this very principle that Mendel applied so effectively in his analysis of segregation, random recombination, and independent assortment.

BREEDING EXPERIMENTS

But Maupertuis was not content with this analysis. He undertook actual breeding experiments with animals to test out his theories, although of the results of these he has unfortunately left us only the account of a single one. It is related (cf. Hervé, 1912) that he "adored animals and lived surrounded by them." "You are more content with Mme. d'Aiguillon than with me," wrote Mme. du Deffand to him one day, "she sends you cats." And Frederick wrote, too: "I know that at Paris just as at Berlin you are enjoying the delights of good company .... I am only afraid that Mme. la duchesse d'Aiguillon is spoiling you. She loves parrots and cats, which is a prodigious merit in your eyes ..." (Potsdam, 15 Nov., 1748). Maupertuis had established himself in the outskirts of Berlin, in a spacious house adjacent to the royal park, near the present Tiergarten; and this house he had converted into a virtual Noah's ark. Samuel Formey, permanent secretary of the Berlin Academy, has left us the following description: "The house of M. de Maupertuis was a veritable menagerie, filled with animals of every species who failed to maintain the proprieties. In the living-rooms troops of dogs and cats, parrots and parakeets, etc. In the forecourt all sorts of strange birds. He once had sent from Hamburg a shipment of rare hens with a cock. It was sometimes dangerous to pass by the run of these animals, by whom some had been attacked. I was especially afraid of the Iceland dogs. M. de Maupertuis amused himself above all by creating new species by mating different races together; and he showed with complaisance the products of these matings, who partook of the qualities of the males and of the females who had engendered them. I loved better to see the birds, and especially the parakeets, which were charming ..." (quoted from Hervé, 1912).

It was of the Iceland dogs that Maupertuis has left us the account of his breeding experiment (1752a, XIV): "Chance led me to meet with a very singular bitch, of that breed (*espèce*) that is called in Berlin the Iceland Dogs: she had her whole body the color of slate, and her head entirely yellow; a singularity that those who observe the manner in which the colors are distributed in this sort (*genre*) of animals will find perhaps rarer than that of supernumerary digits. I wished to perpetutate it; and after three litters of dogs by different fathers which did not yield anything of the sort, at the fourth litter she gave birth to one who possessed it. The mother died; and from that dog, after several matings with different bitches, there was born another who was exactly like him. I actually have them both." This circumstantial account is followed by a consideration of supernumerary digits in dogs: "There are no animals at all upon whom supernumerary digits appear more frequently than upon dogs. It is a remarkable thing that they ordinarily have one digit less on the hind feet than on those in front, where they have five. However, it is not at all rare to find dogs who have a fifth digit on the hind feet, although most often detached from the bone and without articulation. Is this fifth digit of the hind feet then a supernumerary? or is it, in the regular course, only a digit lost from breed (*race*) to breed throughout the entire species, and which tends from time to time to reappear? For mutilations can become hereditary just as much as superfluities."

HIS THEORY OF EVOLUTION

These observations, which well might have been made by Charles Darwin, bring us to Maupertuis' theory of evolution, which is somewhat, but only slightly, better known than his genetics. He was faced with the problem of accounting for super-

numerary digits, albinism, and other hereditary anomalies on the basis of his theory of generation. This he solved ingeniously. "If each particle is united to those that are to be its neighbors, and only to those, the child is born perfect. If some particles are too distant, or of a form too little suitable, or too weak in affinity to unite with those with which they should be united, there is born a monster with deficiency (*monstre par défaut*). But if it happens that superfluous particles nevertheless find their place, and unite with the particles whose union was already sufficient, there is a monster with extra parts (*monstre par exces*)" (*V. P.*, Part I, Chap. XVII). Even Mendel did not foresee deficiencies and duplications of the hereditary material as a basis of abnormal development, a sort of mutation! Maupertuis commented on the remarkable fact that in monsters with extra parts, these are always to be found in the same locations as the corresponding normal parts: two heads are always on the neck, extra fingers are always on the hand, extra toes on the foot. This is very difficult to explain on the basis of the theory that monsters come from the union of two foetuses or eggs, which was the explanation forced upon the preformationists by the nature of their own views; but it was not at all difficult to explain on the basis of Maupertuis' concepts. He described the skeleton of a giant man, preserved in the Hall of Anatomy of the Academy in Berlin, with an extra vertebra in the lumbar region inserted in a regular fashion between the ordinary vertebrae. How could this be the remains of a second foetus fused with the first? he asked.

But on Maupertuis' particulate theory, "chance, or the scarcity of family traits, will sometimes make rarer assemblages; and one will see born of black parents a white child, or perhaps even a black of white parents . . ." (*V. P.*, Part II, Chap. V). ". . . there are elements so susceptible of arrangement, or in which recollection is so confused, that they become arranged with the greatest facility . . ." (*S. N.*, XL); elements which represent the condition in an ancestor rather than that in the immediate parent may enter into union in forming the embryo, producing resemblance to the ancestor rather than to the parent (*S. N.*, XLI); but also "a total forgetfulness of the previous situation" may occur (*S. N.*, XLII).

Maupertuis thus came to the conclusion that hereditary variants are sudden, accidental products—mutations, to use the modern term. Moreover, since negroes could by mutation produce "whites," (i.e., albinos), it was clear that racial, or species, differences—the distinction was not too clear in the eighteenth century—are produced by mutations. To Maupertuis, exactly as to Hugo de Vries a century and a half later, a species was merely a mutant form that had become established in nature. The evidence for such a view was apparent to Maupertuis in the artificial breeds of domestic animals. For him, as for Charles Darwin, the variation in domesticated pigeons was a significant phenomenon. "Nature contains the fund of all these variations: but chance or art brings them out. It is thus that those whose industry is applied to satisfying the taste of the curious are, so to say, creators of new species. We see appearing races of dogs, pigeons, canaries, which did not at all exist in Nature before. These were to begin with only fortuitous individuals; art and the repeated generations have made species of them. The famous Lyonnés every year created some new species, and destroyed that which was no longer in fashion. He corrects the forms and varies the colors: he has invented the species of the harlequin, the mopse, etc." (*V. P.*, Part II, Chap. III). And then Maupertuis boldly inquired why this art should have to be restricted to animals, and suggested that sultans in their seraglios might practise a similar art. He described the efforts of Frederick William of Prussia to build an armed force of giant soldiers, an effort which had had, he thought, a singular effect in increasing the stature of the Prussian people.

If the ingenuity of man can produce species artificially, why cannot nature do the same, whether by "fortuitous combinations of the particles of the seminal fluids, or effects of combining powers too potent or too weak among the particles" (*V. P.*, Part II, Chap. VII), or by the action of the environment, such as the effect of climate or nutrition, on the hereditary elements? It is worth emphasizing, for it has been misunderstood, that Maupertuis did not in this connection suggest the inheritance of acquired characters, the theory later advocated by Lamarck. On the contrary, it is the direct mutational action of heat or other factors on the hereditary material itself that Maupertuis clearly meant. "For the rest," he says, "although I suppose here that the fund of all these variations is to be found in the seminal fluids themselves, I do not exclude the influence that climate and foods might have. It seems that the

heat of the torrid zone is more likely to foment the particles which render the skin black, than those which render it white: and I do not know to what point this influence of climate or of foods might extend, after long centuries of time" (*V. P.*, Part II, Chap. V). It is also very clear that Maupertuis understood that most mutant forms are deleterious and at a disadvantage in comparison with the normal or wild types. "What is certain is that all the varieties which can characterize new species of animals and plants, tend to become extinguished: they are the *deviations* of Nature, in which she perseveres only through art or system. Her *works* always tend to resume the upper hand" (*V. P.*, Part II, Chap. V, italics added). (Cf. also the quotation on p. 199).

How, then, account for the distribution of different races and species? The "thousands" of human varieties are insuperable difficulties for the preformationist; but by mutation, migration, and isolation they are easily accounted for by Maupertuis. He was much struck by the fact that in the torrid zone all the peoples are black, or very dark, in spite of the interruptions caused by the sea; and that "in travelling away from the equator, the color of the people grows lighter by shades. It is still very brown just outside the tropics; and one does not find complete whiteness until one has reached the temperate zone. It is at the limits of this zone that one finds the whitest peoples" (*V. P.*, Part II, Chap. I). Well, "men of excessive stature, and others of excessive littleness, are species of monsters; but monsters which can become peoples, were one to apply himself to multiplying them" (*V. P.*, Part II, Chap. VII). Are there not races of giants and dwarfs? These "have become established, either by the suitability of climates, or rather because, in the time when they commenced to appear, they would have been chased into these regions by other men, who would have been afraid of the Colossi, or disdain the Pygmies.

"How many giants, how many dwarfs, how many blacks, may have been born among other men, pride or fear would have armed against them the greater part of mankind; and the more numerous species would have relegated these deformed races to the least habitable climates of the Earth. The Dwarfs will have retired toward the arctic pole: the Giants will have inhabited the Magellanic lands: the Blacks will have peopled the torrid zone" (*V. P.*, Part II, Chap. VII). However naive these views may be—and they were an easy target for the sharp gibes of Voltaire—there is nevertheless a groping for a real truth here that was only to be fully captured by Charles Darwin and Alfred Russel Wallace in a later day.

There is no naivety, there is only pure genius in these final words: "Could one not explain by that means [mutation] how from two individuals alone the multiplication of the most dissimilar species could have followed? They could have owed their first origination only to certain fortuitous productions, in which the elementary particles failed to retain the order they possessed in the father and mother animals; each degree of error would have produced a new species; and by reason of repeated deviations would have arrived at the infinite diversity of animals that we see today; which will perhaps still increase with time, but to which perhaps the passage of centuries will bring only imperceptible increases" (*S. N.*, XLV).

MAUPERTUIS AND HIS CONTEMPORARIES

Among his contemporaries in biology, the work of Maupertuis was most highly regarded. With Buffon, in particular, Maupertuis had much in common. To Buffon, Maupertuis was the author who seemed to him "to have reasoned better than all those who have written before him on this subject" (of the generation of the individual); and Buffon spoke of the *Venus Physique* as a treatise which, "although very short, assembles more philosophical ideas than there are all told in several great volumes on generation." "This author," he continued, "is the first to have commenced to draw near to the truth, from which we were farther than ever since eggs had been supposed to exist and the spermatic animals were discovered" (quoted from Brunet, 1929).

It is equally significant that Charles Bonnet, the great exponent of preformation, directed his arguments quite as much against the "internal mills" (*moules intérieurs*) of Buffon and the "attractive forces" and the "memory of the seminal molecules" of Maupertuis as against the epigenetic *vis essentialis* of Kaspar Friedrich Wolff. What is often overlooked today is the fact that Bonnet was profoundly right in holding as senseless the view that "that unity, that organic whole one calls an animal" can arise from an *amorphous* semen, and in affirming that a gel (*glu*) which appears to become organized in development must possess an organization to start with. In the end,

writing in the *Palingénésie*, Bonnet arrived at a view of preformation that is as close to our modern understanding as was the epigenetic view of Maupertuis. It is not necessary, he said, to limit the significance of preformation "to express an organic corpuscle that actually encloses in extreme miniature all the parts which characterize the species." It may be extended to include "every organic preformation from which an animal can result as (from) its immediate principle." And again, in the *Contemplation de la Nature*, he wrote: "I do not affirm that the buds which produce separate young polyps (*les rejetons d'un Polype à bras*) were themselves miniature polyps, hidden under the skin of the mother, but I affirm that there are, under the skin certain particles which have been preorganized in such a manner that a little polyp results from their development." Every genesis, in other words, must issue from a "predetermination," a "secret preorganization," a "primordial design." (Quotations from Rostand, 1945.) Seen in this light, there is a close rapprochement between the ideas of Maupertuis and Bonnet, such that the modern theory of the genetic organization of the fertilized egg covers them both. As so often in the history of scientific ideas, the ultimate truth includes those antithetical ideas over which earlier men were embroiled in controversy.

THE REPUTATION OF MAUPERTUIS IN THE 19TH AND 20TH CENTURIES

It remains to account for the reputation of Maupertuis to the present day. There is little indeed to say. Darwin, it would seem, never heard of him. Thomas Henry Huxley (1878), who was the first to make a somewhat careful study of Darwin's predecessors, makes only a cursory reference to his "curious hypothesis as to the causes of variation, which he thinks may be sufficient to account for the origin of all animals from a single pair." Quatrefages, Perrier, Clodd, Packard, Nordenskiöld, Radl, and other historians of the theory of evolution have ignored him completely. Henry Fairfield Osborn, in *From the Greeks to Darwin* (1894), almost completely misunderstood Maupertuis, classifying him with those who made speculations without the support of observation or the least deference to inductive canons. Osborn apparently read only the *Système de la Nature*, which is admittedly difficult to interpret without prior knowledge of the *Venus Physique*. In 1904, Lovejoy published a scholarly study of Maupertuis and other early evolutionists which still remains the most penetrating consideration he has received. Although Osborn knew of this study, he did not make the slightest use of it in preparing the revised edition of his book (1928), and he may consequently be regarded, after Voltaire, as the chief reason for the misapprehension of Maupertuis' significance as a scientist. Yves Delage, the great French historian of biological theories, was just to Maupertuis in discussing the latter's views, in *L'Hérédité et les Grands Problèmes de la Biologie Générale* (1896). He discussed Maupertuis' theories regarding ontogenesis, heredity, variation, and the formation of species in a spirit of admiration, and summed up by saying "Geoffroy Saint-Hilaire could subscribe to his law of teratogenesis; Lamarck, to his ideas on variation; Darwin, to his system of representative germs. And all that had been said by him a century before them!" And Delage compared Maupertuis with Buffon not entirely to the latter's advantage. Nevertheless, it must be remembered that Delage's book was written before the rediscovery of Mendel's laws and before the mutation theory of de Vries was published. In many respects the criticisms of Delage therefore sound antiquated—in matter of fact, some of the imperfections with which he charged Maupertuis have turned out to be the imperfections of Delage. Nor was Delage always correct, as when, for instance, he charged Maupertuis with having been a purely theoretical critic of preformation, or with having believed in the inheritance of acquired characters in a Lamarckian sense. Delage also seems to have regarded Maupertuis' theories as succeeding those of Buffon instead of preceding them, this being due to his listing the *Venus Physique* as first published in 1748, instead of 1744–45. As Lovejoy (1904) has pointed out, it was more likely Buffon who was influenced by the theories of Maupertuis than the reverse; although the differences between the views expressed in the *Venus Physique* and those in the *Système de la Nature* may very well represent the counter-influence.

In this period the common judgment upon Maupertuis was that derived from Voltaire. It is enlightening, for example, to read, in the light of D'Alembert's praise of Maupertuis' clarity and literary style (1778), the dictum of a critic such as Leon Sagnet, writing in *La Grande Encyclopédie* (1896): "Certainly, Voltaire was unjust. Before

covering Maupertuis with insults, moreover, he had praised him above measure. One is none the less obliged to state that the favorite of the king of Prussia was a very mediocre writer, with a style stiff and pretentious, and who, inflated with pride and with his spirit warped by vanity, produced as a scientist, outside of his measurement of the arc of Tornea, neither any work nor discovery of the first rank, that, consequently, the great celebrity which he enjoyed among his contemporaries and the honors with which he was overwhelmed were as little justified as the mockeries of Voltaire were themselves exaggerated."

In 1912 Georges Hervé wrote a brief paper entitled *Maupertuis Généticiste*. This is a very fine critique of Maupertuis' theories in the light of Mendelian genetics, paying tribute to his experimental approach. But it was by no means exhaustive, and, since it appeared in a journal little consulted by experimental biologists, it seems to have been almost completely overlooked. The comments of Curtis (1922) on Maupertuis relied wholly upon the previous analysis by Lovejoy (1904).

Coming to a more recent period, we find a number of biologists referring to Maupertuis, but always in a partial light. Joseph Needham, in his *History of Chemical Embryology* (1931), paid fitting tribute to Maupertuis as an epigenesist, but was not interested in his genetics or his evolutionary theories. F. J. Cole, in *Early Theories of Sexual Generation* (1930), besides an interest in the same subject, seems to have been struck chiefly by the fact that Maupertuis failed to appreciate the importance of the spermatozoa, and by other inadequacies in his views. But he does state that there can be no doubt that Buffon's famous system of organic particles, "his elaborate system of pangenesis . . . was inspired by that of Maupertuis, of which it is a development and extension." Conway Zirkle, in several papers investigating the history of the ideas of pangenesis and the inheritance of acquired characteristics (1935, 1936, 1946) has discussed the ideas of Maupertuis on these subjects. Besides the restriction in point of view, the translation involves several misapprehensions, and Zirkle has confused Maupertuis' arguments in favor of epigenesis and his position as to pangenesis. Émile Guyénot (1941, 1944), alone among modern students of genetics and evolution, has been aware of the significance of Maupertuis, but unfortunately I have not been able to consult his book on *Les Sciences de la Vie au XVII^e^ et XVIII^e^ Siècles*. Guyénot appears to have estimated Maupertuis' evolutionary contribution at its full worth, but has placed less emphasis on his ideas regarding heredity.

CONCLUSION

May we not agree, in conclusion, that this man who argued on genetic grounds against preformation fifteen years before that work of Kaspar Friedrich Wolff which was eventually to dispose of the encasement theory of preformation; who two hundred years ago investigated human heredity in a manner calculated to draw the admiration of any geneticist of the present day, and who applied the mathematical theory of probability to genetics over a century before Mendel; who undertook experiments in animal breeding to throw light on his theories; who formulated a theory of heredity that was particulate and involved the mutual attraction of analogous particles provided by each parent, and that implied segregation, dominance, and independent assortment; and who, finally, formed a theory of organic evolution based upon mutation, natural selection, and geographic isolation;—that this man, Pierre Louis Moreau de Maupertuis, not only deserves to be ranked as a greater than his contemporaries in biology, but stands out as one of the greatest figures in the history of science?

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NEW BIOLOGICAL BOOKS

The aim of this department is to give the reader brief indications of the character, the content, and the value of new books in the various fields of Biology. In addition there will frequently appear one longer critical review of a book of special significance. Authors and publishers of biological books should bear in mind that THE QUARTERLY REVIEW OF BIOLOGY *can notice in this department only such books as come to the office of the editor. The absence of a book, therefore, from the following and subsequent lists only means that we have not received it. All material for notice in this department should be addressed to B. H. Willier, Editor of* THE QUARTERLY REVIEW OF BIOLOGY, *Department of Biology, Homewood Campus, The Johns Hopkins University, Baltimore 18, Maryland, U. S. A.*

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BIOLOGY: HISTORY AND BIOGRAPHY

SCIENCE SINCE 1500. *A Short History of Mathematics, Physics, Chemistry, Biology.*

By H. T. Pledge. Philosophical Library, New York. $5.00. 357 pp. + 15 plates. 1947.

The author of this history of modern science is plainly a very erudite man who can write of many fields as few would dare. Mathematics, physics, chemistry, biology (psychology is excluded)—all fall within his scope. He is not so much interested in biographical incidents as he is concerned with the history of scientific ideas. All of these factors promise well for his truly difficult undertaking, that of disclosing the interrelationships of the several sciences and of the major ideas within these. The orientation of science toward social forces is eschewed.

The outcome, however, is only a partial success, the reasons for which are not far to seek. The threads are too many and too easily lost, the loom too vast. Names of scientists tumble over one another with little personal characterization to make them meaningful. The definition of ideas is broad, marked by hiatuses, or frequently taken for granted. Each section seems to be addressed to those who already know that field and its history rather thoroughly. The biologist, for example, will find the chapters on biology concise and comprehensive. By supplying the hiatuses liberally from his own store of knowledge, he will approve the account as in the main accurate, he will be able to follow the trends of thought, and he will find a certain number of stimulating ideas. Only in his own specialty will he be likely to find the selection of scientists rather arbitrary—at least this was true for modern genetics—and the elaboration of the central ideas lacking in clarity.

Let him venture into a less familiar domain, however, and the biologist will soon founder among the more unfamiliar concepts and unexplained ideas—for the sections on physical science are written for the chemist and physicist, and the mathematical sections for a mathematician. To illustrate: a biologist interested in the development of the concept of probability will find mention in a single paragraph (p. 84) of the "problem of the unfinished game," "the thorny question of inverse probability," "the theory of errors, of how to obtain the best value from a set of non-concordant observations of the same physical quantity," "the method of least squares," and "the normal error law $y = ae^{-x^2}$," all with little or no further elucidation there or elsewhere. The same paragraph contains mention of Fermat, Pascal, Petty, De Witt, Vauban, Graunt, Halley, J. Bernoulli, Lagrange, Euler, Gauss, De Moivre, and Laplace. Nor is this an unusual paragraph. On the contrary, it is fairly representative. Such an account cannot mean very much unless one already knows much more. Perhaps the author will reply that he intended his book for just such an audience. If so, it is a very limited one; and it may be questioned whether anyone with so great a grasp of so many fields will not have made a similar synthesis for himself already. For most of us, the more elementary and more selective history of science by Sherwood

Taylor, reviewed in these columns in the last issue (Q. R. B. 22: 143. 1947), will achieve more.

Two series of figures in the book should arouse considerable interest. One of these is a series of charts showing the connections of master and pupil. The other is a series of maps locating the birthplaces of scientists. These reveal a remarkable clustering in particular regions during certain periods. The author has promised a further discussion of this phenomenon in another work. For the present it remains unexplained.

BENTLEY GLASS

LOGBOOK FOR GRACE. *Whaling Brig Daisy, 1912–1913. By Robert Cushman Murphy. The Macmillan Company, New York.* $4.00 xiv + 290 pp.; ill. 1947.

It has long been the custom for young naturalists who have had the fortune to begin their careers with a voyage to publish the journal of that voyage as their first magnum opus, but Robert Cushman Murphy has reversed that custom. His reputation as a naturalist long established beyond question, he has now dusted off the journal and letters written for his wife thirty-five years ago, and made them into a fresh, readable book. It is a method to be recommended for young naturalists who go to sea, for the passage of years gives the writer a perspective and understanding of his field which enable him to eliminate tedious detail and egregious utterances that he might well regret in later life. The surprising thing about this book is that it still reads like the product of a youthful author despite its long incubation period. In several ways, we are glad that Murphy waited so long to publish his journal. Had it appeared just after the cruise it would probably have been lost in the turmoil of war, and there is something peculiarly nostalgic about this journal of a whaling cruise in a ship whose life was almost spent, in the days when world wars were unthinkable. This is a way of life and a peace of mind we shall never know again. As the journal of a biologist, it leaves nothing to be desired, except perhaps a few illustrations. There have been few descriptions of the Sargasso Sea and of the life of the Antarctic island as fine as those in this book. Of particular interest is the account of Antarctic whaling in its early years, under the direction of Captain C. A. Larsen. Above all, this is a story of the "far away and long ago": of the end of the old and the beginning of a new way of whaling, and of the commencement of a distinguished career in natural history.

JOEL W. HEDGPETH

THE THYROID GLAND IN MEDICAL HISTORY. *By Alfred H. Iason. Froben Press, New York.* $3.00. 136 pp. 1946.

This book is little more than a catalogue of writers, from the time of antiquity on down, who have mentioned the thyroid gland or its disease entities, together with excerpts from their writings, plus an assortment of herbalistic and other lore not always relevant to the topic at hand. There are numerous illustrations of the thyroid diseases, taken from the works of contemporary artists, but reproduced with surpassing obscurity, and not integrated with, or even mentioned in the text. The author has a fund of information about his subject but has chosen to present it almost as a series of lecture notes.

H. R. CATCHPOLE

BANTING'S MIRACLE: *The Story of the Discoverer of Insulin. By Seale Harris, with a foreword by Elliott P. Joslin. J. B. Lippincott Company, Philadelphia, London, and Montreal.* $3.00. xx + 245 pp. + 23 plates. 1946.

Seale Harris is well qualified to write a life of Banting. He is a clinician of high standing who has treated many diabetics, both before and since the introduction of insulin. His own description of a new complex in medicine, that of hyperinsulinism, is a major contribution to our knowledge of the pathology of carbohydrate metabolism. Furthermore, he was a close friend of Sir Frederick Banting and took a profound interest in his work as a scientist and his character as a man. It is therefore not surprising that he has succeeded in writing an extremely interesting biography of one of the most successful investigators of our time. For all who can remember the unfavorable prognosis of diabetes in children prior to Banting's discovery and can compare it to the good outlook a diabetic child enjoys today, the importance of insulin as a therapeutic agent cannot be overestimated. The most fascinating part of the book deals with the steps that led Banting to his discovery. The chapter entitled "Birth of an Idea" is a masterpiece of historical scientific writing. One is able to get a very vivid picture of Banting's personality in the chapters that deal with his childhood and his relations to women. Not often have the personal problems of a contemporary scientist been discussed with so much frankness and tact. The reasons for the failure of Banting's first marriage are treated with great understanding. The frictions with his scientific team-mates are discussed with equal candor. In recording these, the author has been carried away by his admiration for his hero, and it seems probable that one day a more impartial historian of science will do greater justice to Macleod.

The book is written in a very readable style, and its format is most pleasing. The book is to be warmly recommended to everybody interested in the progress

of medicine, and especially to all anti-vivisectionists. Banting could never have performed his miracle without sacrificing some dogs.

WALTER FLEISCHMANN

CHARLES-ÉDOUARD BROWN-SÉQUARD: *A Nineteenth Century Neurologist and Endocrinologist. Publications of the Institute of the History of Medicine, The Johns Hopkins University. Third Series: The Hideyo Noguchi Lectures, Volume V.*

By J. M. D. Olmsted. The Johns Hopkins Press, Baltimore; Humphrey Milford, Oxford University Press, London. $3.00. viii + 253 pp. + 2 plates. 1946.

With this volume, Olmsted completes his trilogy of nineteenth century French physiology epitomized in the persons of Magendie, Claude Bernard, and Brown-Séquard. One in search of artistic unity might hope to find in the last named the inheritor of the tradition of Magendie, the pioneer, and of Bernard, the perfect experimenter. Instead, one encounters an erratic genius who contrived, at the very end of his long life, to become, not so much an elder statesman of physiology, as the most controversial figure in the birth of a new science, endocrinology. As to this, Olmsted has dealt very fairly with Brown-Séquard's role both as founder and chief guinea-pig, and he rightly exonerates him from complicity in the commercial exploitation of endocrine preparations ahead of scientific knowledge.

In the course of an incredibly active life devoted to the experimental method, Brown-Séquard crossed the Atlantic an estimated sixty times, accepted and abandoned Chairs on both sides of it with unacademic dispatch, and was equally at home in France, England, and the United States, his citizenship becoming somewhat ambiguous. This is a story of a scientific life lived in a curiously more spacious age.

H. R. CATCHPOLE

ECOLOGY

THE GENERAL ECOLOGICAL CHARACTERISTICS OF THE OUTBREAK AREAS AND OUTBREAK YEARS OF THE AUSTRALIAN PLAGUE LOCUST (*Chortoicetes terminifera Walk.*). *Bulletin Number 186.*

By K. H. L. Key. Council for Scientific and Industrial Research, Melbourne, Australia. Free upon request (paper). 127 pp. + 8 plates + 3 maps. 1945.

The scope of this investigation is well indicated by the title. In the course of "extensive tours covering a total of some 16,000 miles," 1936–1942, in New South Wales and southern and central Queensland, the outbreak areas of the locusts were considered in relation to climate, topography, and similar pertinent factors. Areas are discussed in a certain amount of detail and treated with evident objectivity. Although repetition of major conclusions is noticeable, a great deal of this is necessary, or at any rate very helpful, in tying together the findings from a study involving so many interrelated complexities. There are common denominators in the ecological picture to be drawn, but the actual materialization of the outbreaks or swarming depends so much upon unknowns or upon chance combination of events that the author's thoroughness in presenting his groundwork may be appreciated.

In general, the climate of the known outbreak areas is such that no one month in the "normal" season is too wet, nor any successive three months too dry, for multiplication of the locust. No correlation between outbreak years and sunspot numbers was discovered. A climatic index in excess of 73 is usually required. Flooding of valleys in dry areas may result in locally good habitat for the insects. Favorable topography is characterized by absence of timber (except for scattered trees) and by the presence of both compact and self-mulching soils. Overuse by livestock and clearing of forested lands tend to increase the extent of the outbreak areas. Two "rather distinct optimal habitats exist, one for the egg stage, and the other for older hoppers and adults. Optimal conditions therefore only arise in an area in which both habitats are present in the form of a mosaic, *the scale of which is adjusted to the normal dispersal range of the insects.*"

The phenomenon of mass movement is associated not only with the large populations found where oviposition and food-shelter habitats are conveniently situated in respect to each other but also with alternating habitat changes, when "a flush of feed following rain is inevitably followed by a contraction of the area remaining green, as the plants mature and the soil dries out in the direction of the food-shelter nuclei." Biologically, "the most fundamental function of the outbreak centre may be conceived as being to provide conditions for the survival and multiplication of locusts at times when their range of dispersal is at a minimum, and at the same time to provide the conditions necessary for an increase in that range of dispersal (by swarm-formation) so that wider areas may be occupied. The concentration of the outbreak centres in an outbreak area is an important factor in this process." And swarm-formation is regarded as a biological disadvantage only secondarily, as "when, under the influence of stimuli that would normally lead them to favourable conditions, the swarms are drawn into areas where a catastrophic change of conditions to an unfavourable extreme is possible."

PAUL L. ERRINGTON

AN ACCOUNT OF EXPERIMENTS UNDERTAKEN TO DETERMINE THE NATURAL POPULATION DENSITY OF THE SHEEP BLOWFLY, LUCILIA CUPRINA WIED. *Bulletin Number 195.*

By Darcy Gilmour, D. F. Waterhouse, and G. A. McIntyre. Council for Scientific and Industrial Research, Commonwealth of Australia, Melbourne. Free upon request (paper). 39 pp. + 3 plates + 1 map. 1946.

Field experiments and statistical studies were combined to obtain fundamental information on the behavior and densities of an insect pest near Canberra between November, 1941, and March, 1942. The chief procedure was to spray them with distinctive stains, and to release them in naturally populated areas. Marked and wild-reared flies together were then systematically trapped, and the contents of the individual traps killed for examination. From the data (especially on proportions of the known numbers of marked flies released and later recovered and the ratios of marked to unmarked flies taken in the traps), density figures of between 0.3 and 5.7 adult flies per acre were arrived at. The densities tended to be higher in spring and autumn and lower in summer. Rates of dispersal of marked flies, effects of meteorological conditions on activities, and other factors more or less influencing results were discussed; and about a third of the bulletin was devoted to statistical treatment. The authors computed the "error involved in the method of estimation of population density . . . to be about 20 percent," but were also careful to state that this "does not include an error, which could not be measured, due to the possibility that the released flies did not constitute an accurate facsimile of the natural population."

PAUL L. ERRINGTON

THIS GREAT AND WIDE SEA.

By R. E. Coker. The University of North Carolina Press, Chapel Hill. $5.00. xviii + 325 pp. + 44 plates; text ill. 1947.

A good popular summary of recent advances in oceanography has long been needed. The only work comparable to this new book is Murray and Hjort's *Depths of the Ocean*, long out of print and available only at collector's prices. This work differs from that classic of oceanography in that it is largely compiled from the authorities, and has relatively little first-hand material in it.

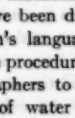
Designed primarily as a text in marine biology, *This Great and Wide Sea* is also intended to appeal to anyone who is interested in the sea and its life, for it is written in simple, direct language, and is well organized into an integrated book. There are, of course, the usual interesting facts about life in the seas, but the book is not intended to be merely a storehouse of odd facts, and the interrelationships of life and the marine environment are constantly emphasized. This interrelationship becomes tenuous in the footnote (p. 149), discussing tidal strain on land: "It may be, however, that these strains set off some earthquakes, and that something is felt by the catfishes whose movements are said to presage by many hours the occurrence of earthquakes on Asiatic shores." Perhaps so.

It is particularly welcome to see the first 56 pages of the book devoted to an introduction to the history of oceanography. The remainder of the first half of the book is concerned with the physics and chemistry of the oceans, with bottom deposits, tides, and similar matters. The concluding half of the volume is a discussion of marine biology. After two introductory chapters, this is broken down into extended discussions of the plankton, benthos, and nekton. Under the last category the fisheries are considered, but more space might have been given to specific problems of fisheries biology.

While the formidably mathematical texts of Sverdrup and his colleagues have been drawn upon freely, and translated into layman's language, so to speak, there is little mention of the procedures now in common use by physical oceanographers to determine the movements and relations of water masses. Bjerknes is given passing mention, but his famous theorem is not, although Stokes' law concerning the fall of a spherical body though a liquid is given in a footnote. This suggests that at least the same should have been done for Bjerknes' theorem, in view of its importance in modern oceanography. Nevertheless, it is remarkable that the author has covered as much ground in 300 pages of text as he has.

There is a short selected bibliography and a 20-page index. The illustrations are of the usual sort—ships, laboratories, instruments, strange fish, and so on.

JOEL W. HEDGPETH



THE RUFFED GROUSE: *Its Life Story, Ecology and Management.*

By Frank C. Edminster. The Macmillan Company, New York. $5.00. xxviii + 385 pp. + 56 plates. 1947.

The ruffed grouse has been studied more intensively, and over a longer consecutive period of time, than almost any other American game bird. Much of the work that has been done is still unpublished; what has been reported is scattered through a wide variety of sources, many of which are not generally available. Edminster has done a welcome service in bringing together a great deal of this scattered material, especially that part which has to do with the northeastern United States. Nor does he speak only as a compiler: his seven years of grouse research qualify him unusually well for the undertaking.

His intent is not to give an exhaustive treatise, but "to cover the high spots of the life story, the ecology, and management of the ruffed grouse in a manner interesting to the sportsman, the nature lover and the lay reader, and at the same time be accurate and adequately documented for the technical man in the field of wild life management" (p. x). The material on the life story is given in three chapters: classification, description, etc.; chronicle of the ruffed grouse in eastern United States; and a generalized life history. Ecology is covered in chapters on cover, food and water, weather, interrelationships with other animals, diseases and parasites, man's relationship, productivity and populations. Ruffed grouse management is the subject of the final chapter. "References and Citation Sources" are given at the end of each chapter; there is an 11-page index. The 55 plates are a series of excellent photographs, placed in the center of the book for easy reference.

Edminster has been modest in saying that his book covers only the "high spots." His chapter on "Shelter" includes discussions of the following, based on the northeastern states: types of grouse range; characteristics and composition of cover types; interspersion of types; changes due to plant succession; nesting cover—general types, placing of nests, nests in relation to openings and slope, nesting cover and predation; brood cover—general preferences, use of cover in relation to the different parts of the day, to slope, to openings, and to weather; cover used by adults—differences in the use of the several types at different times of the year and of the day, the effect of openings, of slope, of weather, and relation of cover to predation on adults.

The author's wish to write for so varied an audience has resulted in a style which at its best is refreshingly direct and informal, even poetic in parts of the chapter entitled "Biography". At its worst (in the same chapter), it has the faults common to most second-rate animal stories, sacrificing accuracy to effect. For example, in the description of injury-feigning, Edminster says: "... she decided to make her escape. But realizing that other lives than her own [pipping eggs] were now at stake she had to be more resourceful than to merely flush quickly to her own safety" (p. 37). Again, perhaps from the wish not to be over-technical, he has not described the census method on which his population figures are based, how males were distinguished from females in the field, how first nests were distinguished from renestings, and the like. Occasionally he has not shown the data on which a conclusion was based. The technical man, surely, is interested in such points. In his discussions of population cycles the author emphasizes so often the fact that the cyclic decline which was due in the 1930's did not occur in the northeast that I, at least, do not know whether he considers the ruffed grouse to be cyclic or not.

There is urgent, even desperate, need to have technical data in the field of conservation translated into readable form. Edminster deserves credit for actually trying to do what the rest of us, for the most part, are only talking about. He is least credible where his style is most "popular," and to that extent he has not accomplished his purpose. In the main, however, *The Ruffed Grouse* is a highly useful contribution to the literature on the species.

F. N. Hamerstrom, Jr.

The California Ground Squirrel: *A Record of Observations Made on the Hastings Natural History Reservation.*

By Jean M. Linsdale. University of California Press, Berkeley and Los Angeles. $5.00. xii + 475 pp. 1946.

This account of an eight-year (1937–44) local study of the sciurid, *Citellus beecheyi*, exemplifies a method of very detailed, direct observation of a native species living with relative freedom from interference by man. It is true that many squirrels were live-trapped for marking, identification, etc., in connection with the investigations, that specimens were killed when needed for post mortem examination (largely, however, from the vicinity of buildings), and that the ecological successions and other changes resulting from human land use had their influence on wild populations. Yet the latter lived and died essentially in a manner "natural" to wild animals.

Chapter headings concern the habitat of the ground squirrels, vertebrates associated with them, communication, mannerisms, activity, food, diseases and parasites, reproduction, numbers, and structure. In these, the psychologist should find as much of interest as the ecologist, for examples of observed behavior under a wide range of circumstances are given liberally. Nearly half of the 51 titles in the bibliography relate primarily to diseases and parasites, especially to plague. The general biologist should appreciate the information presented on reproduction, growth, morphology, and like topics that received attention during a program obviously planned to investigate a specific mammal as fully as practicable.

Students of population may note outstanding factual contributions and unanswered questions, alike. The correlation between the recent decline and disappearance of ground squirrels and the recovery of the land from cultivation looks convincing, but may this be in part tied up with a pattern of fluctuations? Will the squirrels, once gone, remain absent from the reverted lands more or less permanently or until the environment may again favor them? To what degree might the habitats, now squirrel-vacant, become repopulated during ascendancies of squirrels elsewhere,

chiefly as an overflow phenomenon? And what really happens to reduce or stabilize well-situated colonies of ground squirrels left unmolested by man? References to predation, fighting, movements, and disease afford limited grounds for critical exploration of population mechanisms, particularly as such may be linked with the density factor that is basically so influential in regulating populations of higher vertebrates.

The suggestion that "a possible way to keep squirrel numbers at a low stage on pasture land is to fence out the domestic stock from sites most suitable for colonies" (p. 391) introduces an alternative to the conventional procedure of poisoning ground squirrels, an accompaniment of which is often an increase in "the rate of producing young by the survivors" (pp. 338-339). Artificial manipulation of strategic habitats has been successfully used for either increasing or decreasing various kinds of wildlife, and ground squirrels should be appropriate subjects for this type of experimentation.

PAUL L. ERRINGTON

EVOLUTION

LES DOCTRINES DE GEORGES CUVIER *dans Leurs Rapports avec le Transformisme. Encyclopédie Biologique, XXIV.*

By Georges Dehaut. Paul Lechevalier, Paris. 130 fr. (paper). viii + 35 pp. 1945.

This brief work is dedicated to the task of correcting current evolutionary theory by bringing it back to the three great doctrines of Cuvier. With the second and third, of these, the principle of the correlation of the parts of an organism and that of the migrations of fauna, neo-Darwinians will have no disagreement. Dehaut illustrates these with a number of most interesting examples, particularly from the peccaries. He has noted a variant peccary skull possessing a lacrymal bone with an extra-orbital piece, like that which occurs in the hippopotami; and a variant hippopotamus with supraciliary openings, normally absent in those animals but present in peccaries. He has noted that the neotropical peccaries also reveal a parallelism with the marsupial opossum, in the juvenile structure of the glenoid fossa of the skull.

These and other striking examples of parallelism Dehaut seems to regard as convincing evidence of the occurrence of "transmutations," of great magnitude and always sudden (cf. Goldschmidt's macromutations). These "transmutations" differ from "variations" of the Darwinian type, such as are involved in the origin of the Australoid race of the human species. "Variations," being small, are of significance only in the struggle for existence within the species. This distinction between "variations" and "transmutations" is the first great doctrine of Cuvier: "Ce qui a changé a changé subitement, et n'a laissé que ses débris pour traces de son ancien état." Dehaut therefore believes that the physiological isolation of races (as in *Lacerta muralis*) does not lead to the fragmentation of one species into several. DeVriesian mutations, apparently confined to plants, are sudden variations, but of small magnitude, and are not to be confused with real "transmutations." Orthogenesis comes in for approval.

It is only too apparent that Dehaut is not conversant with modern evolutionary theory and that for him the immense field of genetics in relation to the origin of species simply does not exist.

BENTLEY GLASS

A CENSUS OF THE DETERMINABLE GENERA OF THE STEGOCEPHALIA. *Transactions of The American Philosophical Society Held at Philadelphia for Promoting Useful Knowledge, New Series—Volume XXXV, Part IV.*

By E. C. Case. The American Philosophical Society, Philadelphia. $1.25 (paper). Pp. 325-420; ill. 1946.

This monograph is the work of a man who has made a life study of early amphibians and reptiles. Consequently the present publication is based upon Case's encyclopedic knowledge of the labyrinthodont amphibians (for which animals he uses the older term, Stegocephalia), and it represents a summation of his views regarding these early tetrapods. It is an authoritative work that will be consulted frequently in the future by all paleontologists interested in the problems of labyrinthodont evolution and classification.

In his introduction, Case discusses the general problem of labyrinthodont taxonomy and comes to the conclusion that in a study of these animals the species as they have been named are virtually useless. In fact, he maintains that in most paleontological work species are of little value, and in light of this consideration he does not extend his treatment of the labyrinthodonts below the generic level.

He discusses the so-called non-adaptive and adaptive characters of the group and then goes on to a comparison of labyrinthodont classifications made by various authors in the past. There follows a section on the stratigraphy of the beds in which labyrinthodonts are found, and this includes a comprehensive table which correlates the various labyrinthodont-bearing formations the world over.

The bulk of the work is devoted to a consideration of the genera of labyrinthodonts. The definitive characters of each genus are listed, and the genus is briefly discussed. There are numerous figures of the skulls, and these are particularly useful, since they

gather together in one publication data that previously have been scattered through a large body of literature.

In his detailed consideration of the labyrinthodonts, Case takes up the groups Phyllospondyli, Lepospondyli, Embolomeri, Rhachitomi, Stereospondyli, Adelospondyli, Ichthyostegalia, and Seymouriamorpha. It is not quite clear from his treatment what rank he accords these amphibian categories, but it would appear that he regards each of them as an order. In retaining the Phyllospondyli, Case differs with Romer, who would suppress this category. Romer regards the so-called phyllospondyls as small, and in many cases larval, labyrinthodonts that can be placed within other known families and orders. Case considers the Ichthyostegalia as closely related to the embolomeres. He accepts Watson's order Adelospondyli. In discussing the Seymouriamorpha he points out the confusing nature of the evidence as to the larger relationships of this group, the result, he thinks, of the independent evolution of these animals from the primitive labyrinthodont stem. It is his considered opinion that the Seymouriamorphs probably show a dominance of reptilian over amphibian characters.

While Case was preparing his study of the labyrinthodont amphibians, Romer was quite independently making a separate study of these same amphibians. Romer's monographic study, entitled *Review of the Labyrinthodontia*, has just appeared as a Bulletin of the Museum of Comparative Zoology. It will be interesting to compare the work of these two authorities.

EDWIN H. COLBERT

THE GALAPAGOS FINCHES (GEOSPIZINAE). *A Study In Variation. Occasional Papers of the California Academy of Sciences No. XXI.*

By David Lack. California Academy of Sciences, San Francisco. $2.50 (paper). vii + 151 pp.; 4 plates. 1945.

DARWIN'S FINCHES.

By David Lack. Cambridge, at the University Press; The Macmillan Company, New York. $4.50. x + 208 pp. + 9 plates; text ill. 1947.

Darwin, in many of his writings, credits the fauna of the Galapagos Islands with having had a decisive influence on his interest in evolution. Together with the giant tortoises it was a group of peculiar finches with a "perfect gradation in the size of the beaks in the different species" that excited his imagination and started him in 1837 on the studies that culminated twenty-two years later in the publication of the *Origin of Species*. A voluminous literature has accumulated on the remarkable Galapagos finches in the 110 years since Darwin discovered them. However, even after subsequent expeditions had accumulated large collections, there continued considerable dispute as to the origin of these species and their evolutionary history. Some authors contended that there were no well-defined species among the Galapagos finches, but merely focal points with complete intergradation. According to Lowe, on the other hand, all the species freely hybridize with each other and form new species in this manner.

David Lack visited the islands in 1939 to clear up the problem. He found that the species of Galapagos finches are—in spite of their morphological similarity—as well defined biologically as are the species of other groups of birds, and that the evidence was consistent throughout with their origin through geographic speciation. Detailed data on measurements and variation are given in the earlier publication, which also contains a description of the life history. The bill, virtually the only difference between some of the species, plays an important role in the courtship as a species recognition mechanism. However, as shown in the 1947 book, this is probably a secondary function, and the size difference evolved originally as an adaptation to different kinds of food. Piece by piece Lack piles up the evidence for the thesis that there is a selective advantage in closely related species to be adapted for different ecological niches, in fact, that they would otherwise be unable to coexist. Where one species is absent on an island, one of the other species may invade its niche and then become morphologically more similar to the absent species. Adaptive radiation in the Galapagos finches has not proceeded nearly as far as in the Hawaiian honeycreepers, although there are now ground- and tree-feeding species, one warbler-like finch, and one that feeds woodpeckerlike and pokes cactus needles or little sticks with its beak into holes to force out hidden insects.

Lack's *Darwin's Finches* promises to become a classic in the evolutionary literature. Its unique attraction consists in the combination of a simple but captivating presentation with complete scientific soundness and much originality. The non-specialist will enjoy reading this provocative study of the microcosms of one group of organisms and will receive at the same time an introduction into many of the more important problems of evolutionary biology. The specialist will appreciate the elegant evaluation of the effects of natural selection and the skillful joining of ecological and evolutionary research. In every way this is a most important addition to our biological literature.

E. MAYR

GENETICS AND CYTOLOGY

ADVANCES IN GENETICS. *Volume I. Edited by M. Demerec. Academic Press, New York.* $7.50. xvi + 458 pp. 1947.

The appearance of a new periodical among the existing

multitude seems to warrant an examination of its aims. The present volume is offered, according to its editor (or editorial board), not, as might be supposed, because genetics advances so rapidly that its ground cannot be covered by reviews in the existing periodicals; it is offered, rather, "in order that critical summaries of outstanding genetic problems . . . may appear in a single publication," instead of being scattered among a considerable number of review periodicals. If *Advances in Genetics* can achieve this concentration it will be an undoubted convenience. The experience of series of a more or less similar kind in other fields does not give much cause for optimism on this score, however, and it seems probable that we shall in fact have an extra volume of genetical reviews in addition to those scattered in other periodicals.

The pertinent question in this event, Do we need more reviews? seems to this reviewer highly debatable. Whatever one's attitude, however, a duplication of reviews would surely be a rather unfortunate thing; and this is what has happened in one case here—an article by Irwin on Immunogenetics, admirable in itself, contains very little that has not been reviewed recently elsewhere.

The selection of subjects for this volume lays considerable emphasis on speciation—in *Crepis* (E. B. Babcock), in fish (M. Gordon), in the Maydeae (P. C. Mangelsdorf), in *Gossypium* (S. G. Stephens), and in polyploids in general (G. L. Stebbins). Two papers deal with practical breeding information—on forage crops (S. S. Atwood) and on cattle (R. R. Shrode and J. L. Lush). The remaining contributions are on Immunogenetics (M. R. Irwin), the genetics of *Paramecium* and *Euplotes* (T. M. Sonneborn) and mutations in wild populations of *Drosophila* (W. P. Spencer).

EILEEN S. GERSH

HUMAN GENETICS. *Volumes I and II.* *By Reginald Ruggles Gates. The Macmillan Company, New York.* $15.00 set. xviii + 742; vi + 743–1518 pp. 1946.

In a strict sense, Gates' mammoth compilation of human hereditary traits is not a treatise of genetics at all. That is to say, in spite of its first four chapters devoted to the general principles of heredity in man, to human cytology, and to linkage, this work offers no formal or complete exposition of genetic principles as exemplified in human data. As a compendium of genetic information on man and a source book for those who desire to look up some particular hereditary condition, *Human Genetics* is a most valuable reference.

The hereditary traits are grouped under the following headings: eye color and hair color; colorblindness; variations and abnormalities of the eye; and of the ear; albinism; abnormalities and diseases of the skin, hair, nails, and teeth; anatomical abnormalities of the hands, feet, and limbs; anomalies of the skeleton and of bone structure; metabolic defects and derangements; hemophilia and related conditions; other diseases and abnormalities of the blood system; the blood groups—genetical and racial aspects; allergy; syndromes; abnormalities of the alimentary canal and adnexa; sexual and intersexual conditions; twins and twinning; muscular and neuromuscular abnormalities; variations, defects, and diseases of the nervous system; mental defects; normal mental differences; cancer; constitution, body-build, and susceptibility; congenital anomalies; stature and size; anthropological characters; and "odds and ends." The literature references, which follow the chapters, are numerous. The index alone (placed in the second volume, a matter of some inconvenience in using volume one) occupies 90 pages. From this description it may be seen that coverage of the field has been thorough, the work vast, and its usefulness as a reference unmatched in its domain.

The work is, however, subject to certain criticisms. The compilation is just that, and rarely amounts to a critical review of the evidence. Inasmuch as the latter is often conflicting as to mode of inheritance, etc., the reader must be prepared to exercise his own judgment. Although penetrance and expressivity are discussed among the general principles applicable to human inheritance, their great significance in the variable manifestation of particular traits is not sufficiently emphasized. Much of the conflicting evidence as to dominant vs. recessive modes of inheritance can be reconciled when the incomplete penetrance of so many human genetic traits is kept in mind. Gates is also inclined to rely overmuch on the usefulness of his view that translocations account for the now sex-linked, now autosomal inheritance of certain conditions. In the light of the phenomenon of similar phenotypes produced by different genes, a phenomenon so widespread among all genetically investigated species, this hypothesis seems quite unnecessary. Gates also seems to regard the association of characters in the general population (e.g., eye color and hair color) as evidence of linkage, although it is well-known that this is no indication of linkage at all. However, it is often difficult to know just what the author's views are, since so many conflicting theories and hypotheses are presented without any resolution of their differences that the ultimate feeling of the reader is often one of bewilderment.

The organization of the material is also inadequate in certain respects. The chapters and leading topics provide clear categories, but within the topics the order is neither that of a historical study nor one arranged on any other obvious logical basis. Too often the effect created is that of a hodgepodge. For example, in the discussion of hemophilia and related conditions, one jumps without apparent reason from hemophilia to thrombopenia to hemophilia again to thrombopenia

again to "pseudo-"hemophilia, fibrinogenopenai, thrombopathy, and finally back to hemophilia again. As the topics are often many pages long, it becomes impossible to collect all the information given on one trait without the excessive labor of covering the entire section—or often the entire chapter. No index can cope with such a lack of careful organization on the primary level.

In spite of such defects, this book is sure to be indispensable not only to geneticists and workers in medical research, but to many other biologists as well. Since the work of Baur, Fisher, and Lenz, which it most resembles, is now too old for reliable use, *Human Genetics* will occupy a key position among genetic reference works. It is all the more unfortunate that it cannot quite live up to the responsibilities of that position.

BENTLEY GLASS

GENETICS, MEDICINE, AND MAN.

By H. J. Muller, C. C. Little, and Laurence H. Snyder. Cornell University Press, Ithaca, New York. $2.25. xii + 158 pp. + 2 plates; text ill. 1947.

These six lectures to a general audience, given at Cornell University in the fall of 1945, present the relation of heredity to medical and social problems, as three noted geneticists of our time see it. Although united by a common theme, the speakers differ markedly in their general approach. Muller, in the Work of the Genes, describes the nature of the hereditary material, and of mitotic cell division as the central process in its transmission. He takes up gene interactions and the relation of genes to enzymatic cell processes, dwells on the question as to how the gene reproduces itself, and considers the nature of the process of mutation and its relation to the origin of life. In his second lecture, The Dance of the Genes, Muller defines the biological function of sex (fertilization and meiosis) as the production of hereditary variation through the combination and recombination of mutant genes. He presents a highly stimulating discussion of the effects of linkage and crossing over upon this combination and recombination, and ends with an analysis of the factors governing gene equilibria in a population. The applications of this knowledge to the social control of human evolution are implied rather than outspoken.

Little, in his two lectures (Parental Influence; Growth and Individuality) shows himself chiefly concerned with the variety of the mechanisms whereby parents influence their young. He gives examples on three levels, the morphogenetic, the emotional-endocrine, and the psychosocial, emphasizing the value of studying mammalian genetics for the light it throws upon similar human problems and situations. The interaction of heredity and environment in the growth processes is stressed. Individuality, conceived as a biochemical entity, is found to be definable by studies of the fate of tissue transplants between individuals of highly inbred strains at various ages, and is found to wax with increasing age up to maturity and then to wane. Little is thus chiefly concerned in these lectures with the adjustment of the individual to all levels of the environment, and with the relation of parents, growth processes, and individuality to that adjustment.

Snyder discusses particularly the practical applications to medicine of a knowledge of human heredity. He illustrates these applications to prognosis, to diagnosis, to prevention, and to medico-legal problems. In his second lecture, he classifies the relations of the mutant gene in man as spatial, physiological, ontogenetic, and phylogenetic, and presents a clear and effectively illustrated account of genetic research on man in these four areas.

As a whole, the book will hold less interest for geneticists than for other biologists, since it is a summation and clarification of genetic thought rather than a detailed exposition of medical or theoretical genetics. The expression and organization of thought in the book will be stimulating to all. Its chief function will have been served if it leads to a deepening understanding among non-geneticists of what genetics has to contribute to the biological view of man.

BENTLEY GLASS

ÉLÉMENTS DE GÉNÉTIQUE (*Science de l'Hérédité*). *Collection "Lovanium."*

By Ernest Van Campenhout. Casterman, Tournai, Belgium; and Paris. 60 fr. Belg. (paper). 196 pp. 1946.

This seems to be intended as an introductory book for the general reader. A relatively long chapter on Mendelian inheritance in man is introduced by seven brief chapters presenting Mendel's laws and the chromosomal basis of inheritance. There follow comments on practical applications of genetics (including eugenics) and some special aspects of heredity (cytoplasmic inheritance, atavism, etc.).

Interest is focussed mainly on human genetics, and it is unfortunate, therefore, that the information given in this field, as in others, is in several instances misleading, if not inaccurate. For example, inadequate treatment of multiple factor inheritance results in an oversimplified picture of the inheritance of some traits; and the terminology used in discussing the blood groups might well leave the reader with the impression that the AB type is the universal donor.

This is not an outstanding book of its kind.

EILEEN S. GERSH

GENERAL AND SYSTEMATIC BOTANY

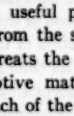
AN INTRODUCTION TO BOTANY. *Second Edition.*

By Arthur W. Haupt. McGraw-Hill Book Company, New York and London. $3.50. xii + 425 pp. 1946.

As in the case of the first edition of this text—designed primarily for a one-semester course in plant science, with or without laboratory work—the second edition is an introduction to such basic facts and principles concerning plants as are essential to an understanding of their structure, general physiology, life relations, and evolution. An effort has been made to achieve a well-balanced treatment notwithstanding rigid restriction of material. In Part I, which deals principally with the vegetative and reproductive organs of the seed plants, the material has been so reorganized that in the case of each root, stem, leaf and flower, structure (both gross and minute) and functions are considered together. This improvement has necessitated the rewriting of certain topics and the addition of considerable new material, including illustrations. In accord with the prevailing practice in general botany texts, increasing attention is given to useful products derived from plants, in particular from the seed plants.

In Part II, which treats the evolution of the plant kingdom, new descriptive material and illustrations have been added to each of the chapters on the major plant groups. This section is concluded with a chapter on the Plant Life of the Past, one on the Principles of Evolution, and a very useful section listing "Visual Aids" which may be employed to supplement interestingly the material of certain chapters of the book, and the sources from which these films may be obtained.

LADEMA M. LANGDON



TEXTBOOK OF BOTANY. *Ninth Edition.*

By J. M. Lowson. Revised and largely rewritten by W. O. Howarth and L. G. G. Warne. University Tutorial Press, London. 13/6. viii + 584 pp. + 9 plates. 1945.

This is the ninth edition of Lowson's well-known book, which has been used so widely in English schools as an introductory text in the study of botany. Brought up to date by the incorporation of modern findings and interpretations, it approaches the subject from the point of view of structure and function as exhibited in the angiosperms, proceeding from there through the ferns, gymnosperms, bryophytes, algae, fungi, bacteria, and viruses, thus reversing the order of presentation found in most American textbooks. Profusely and well illustrated, it covers most topics in considerable detail, with no attempt to spare the student from the wealth of technical terminology. The text is, however, quite readable. The book is concluded with a list of 163 test questions and an appendix of general advice to the student, a list of Greek and Latin roots of botanical terms, and a section on microtechniques.

C. P. SWANSON

ECONOMIC BOTANY

SHRUBS IN COLOUR AND CULTIVATION.

By T. C. Mansfield. E. P. Dutton & Company, New York. $5.00. viii + 263 pp. + 80 plates. [1945].

Occasionally a book turns up which provides the specialist with detailed information at the same time that it is a source of delight to the less well-informed. This is just such a book. Beautifully illustrated with 80 plates in color photography, it describes most of the shrubs which can be grown in a temperate climate, including many which are better known to the English gardener than to the American (the author is a well-known English horticulturist). The first 31 pages deal in general terms with rules of landscape planting, propagation, transplanting, maintenance, and soil characteristics, while the glossary, occupying the remainder of the book, takes up each shrub in alphabetical order of generic name. Each shrub is listed as to family, genus, species, named varieties, origin, origin of generic name, time of flowering, color of foliage and blossoms, size and height of plants when mature, method of propagation, and soil preference. The taxonomist may quibble about the fact that botanical names are cited without the accompanying authority, but this will probably be a minor source of irritation to the horticulturist and the lover of shrubs for whom the book is written. There are a few errors. Plate 46 is of *Hypericum Kalmiamum*; no reference is made to it in the text, thus leaving the reader in some doubt as to its use and desirability. The errors, however, are minor, and do not appreciably detract from a book which deserves a place on the shelf of those who have gardens and who desire to know something of the individuality of the shrubby plants which can be grown.

C. P. SWANSON

GENERAL AND SYSTEMATIC ZOOLOGY

A CHECK LIST OF BRITISH INSECTS.

By George Sidney Kloet and Walter Douglas Hincks with a preface by N. D. Riley. Kloet & Hincks, Stockport, Eng. £2 12s. 6d. lx + 483 pp. + 1 plate. 1945.

To have produced a check list of the scope and quality of this work during the period of the world's greatest upheaval is worthy of praise and congratulations. The list includes the insects known to inhabit England, Scotland, Wales, Ireland, The Isle of Man, Isle of Wight, Scilly Isles, the Hebrides, and the Shetland Isles. The Channel Isles are excluded. The book is printed on a good grade of paper and is well bound.

In the introduction the authors give an account of the difficulties under which they worked, such as enemy fire, war duties, destruction of manuscripts, etc. This is followed by an historical survey of previous "British Lists," a general bibliography, and finally the check list, with generic and subgeneric index.

The authors have made good use of signs and symbols, which are explained in detail in the introduction. Being a check list, there is no reference to range or original descriptions. The genotypes are indicated when the species occurs in the area covered by this work. Unfortunately, there is no reference as to the source of this information. That slight addition would have greatly increased the value of this work to the systematist. A unique feature is the marking of invalid names and of names needing further research. This feature should encourage the taxonomist to new efforts toward the clarification of these names.

Turning now to the names listed, nothing too much can be said as to its completeness. There are more names listed than ever before recorded from the British Isles. The authors do not follow any one system of arrangement within the orders. Inasmuch as this is a check list only, it might have been better to have followed some generally used system of arrangement and to have indicated at the beginning of each order what system was used. For the most part, however, the authors have been conservative in their selection of names. They have not been prone to splitting, at least in the Coleoptera, which is the current trend in Europe. They have followed the old order of arranging the butterflies. There is still the controversy over the Meigen (1802) names in the Diptera, and hence some inconsistencies in that group.

The confusion over family names has not been eliminated in this work. The authors have not used the family names given in the *Zoological Record*, as one might have expected them to do, so the difficulty of knowing exactly what is meant by certain of the family names used exists in this work as in others.

Kloet and Hincks clearly state in the introduction that they do not expect this work to meet the exacting demands of the specialist, inasmuch as the specialist is unable to make his knowledge generally available to cataloguers. This is therefore stated to be a preliminary list, to be worked over by the specialist within the next five years so that it may be revised and corrected. The work will serve a double purpose, not only as a guide in arranging collections, but as an incentive to further work by the taxonomist. For this the authors are to be highly commended.

ROBERT MATHESON

COPEOGNATHA. *The Zoology of Iceland, Volume III, Part 41.*

By B. Fristrup. Ejnar Munksgaard, Copenhagen and Reykjavik. Kr. 0.40 (paper). 4 pp. 1942.

NEUROPTERA AND TRICHOPTERA. *The Zoology of Iceland, Volume III, Parts 43–44.*

By B. Fristrup. Ejnar Munksgaard, Copenhagen and Reykjavik. Kr. 2.25 (paper). 23 pp.; text ill. 1942.

HEMIPTERA 1. *Heteroptera and Homoptera Auchenorhyncha. The Zoology of Iceland, Volume III, Part 51.*

By B. Fristrup. Ejnar Munksgaard, Copenhagen and Reykjavik. Kr. 1.85 (paper). 21 pp.; text ill. 1945.

Each of the above monographs lists and discusses the Icelandic species of the respective orders. Detailed locality records, maps of the distribution, and notes on the biology of the species are given. At the end of each part is presented a general discussion, with tables, showing the distribution of each species throughout the various areas in the Holarctic Region. Such data will be invaluable to the zoogeographer.

Iceland has a pauperitic insect fauna. Only four species of Copeognatha, one Neuropteron, ten Trichoptera, and thirteen Hemiptera are known. None of these are endemic: many are either cosmopolitan forms or representatives of the Scandinavian fauna, most of which have apparently reached the island through the agency of man.

ROBERT MATHESON

LADYBEETLES OF THE GENUS EPILACHNA (SENS. LAT.) IN ASIA, EUROPE, AND AUSTRALIA. *Thomas Lincoln Casey Fund. Smithsonian Miscellaneous Collections, Volume 106, Number 15. Publication 3860.*

By G. H. Dieke. Smithsonian Institution, Washington, D. C. $1.00 (paper). iv + 183 pp. + 27 plates. 1947.

This, the sixth contribution published by the Smithsonian Institution under the Thomas Lincoln Casey Fund, is a welcome addition to our knowledge of the Coccinellidae (Coleoptera). The revision is based on a large amount of material from the area under consideration. It is unfortunate that African and American material was not available for a more complete study of the Epilachninae. The author recognizes eight genera in the subfamily as treated. All of the species have been thoroughly studied and well illustrated. Full descriptions are given of each species with its variations, subspecies, and its known distribution. The external morphology of each is carefully described and the genitalia of both males and females are figured. Most commendable are the author's evaluations of the color patterns of these beetles. All typical forms are illustrated, and the variations of these patterns are fully discussed. However, his classification itself is based on morphology and not on the color patterns, as his predecessors have done. The known biology of most species is also given.

It is unfortunate that the author omits keys to most

of the groups. However, his descriptions are so clear that it will be possible for any worker to decide what species is before him. Aside from this one omission, the monograph should prove of great value to the working entomologist, especially since many of the species are of economic importance.

ROBERT MATHESON

BIOLOGIE DES ABEILLES. *Les Travaux et les Jours. By Maurice Caullery with the collaboration of P. Grassé, L. Berland, P. Grenier, Germaine Cousin, M. Mathis, and E. Roubaud. Presses Universitaires de France, Paris.* 50 fr. (paper). viii + 240 pp. + 20 plates; ill. 1942.

The title of this book is misleading, inasmuch as it contains considerable subject matter only indirectly related to the biology of bees. The book is a compilation and is presented somewhat in the manner of a symposium. Good summaries of different phases are presented by various well-known entomologists. The senior author treats the historical development of our knowledge of bee biology, P.-P. Grassé writes on social insects in general and the evolution of social bees in particular, L. Berland discusses solitary and social wasps, P. Grenier presents the anatomy and physiology of the honeybee, G. Cousin sketches briefly the reproduction and development of honeybees, N. Mathis and E. Roubaud summarize the diseases of honeybees, and the book concludes with a French translation of the papers of two American workers, L. Watson and W. Nolan, on the artificial fertilization of queen bees.

The book is aimed at the amateur biologist or amateur beekeeper, and it contains a wealth of information in readable form. For the most part nontechnical terms and simple French construction prevail. The paper is of poor quality, but this is offset in part by 20 excellent photographic plates on glossy paper.

R. M. BOHART

THE FISHERMAN'S BEDSIDE BOOK. *Compiled by "B. B." Illustrated by Watkins-Pitchford. Charles Scribner's Sons, New York.* $4.00. xxii + 568 pp. 1946.

This anthology, composed of over 150 selections, does not belong to scientific literature in the strict sense, but rather to the literature of natural history—including the natural history of man, for observations on the ways of fish are equalled here by those on the habits of men.

Most of the authors represented are Englishmen. American readers will recognize Gilbert White of Selborne, Tate Regan of the British Museum, W. H. Hudson, Thoreau, Lord Grey of Falloden, A. R. B. Haldane, John Burroughs, and others. The material is organized roughly—very roughly—by fish: salmon, trout, carp, pike, and the rest, with sections on fish ponds and other matters. With all due respect to the learned Docteur Lebault, dead these 200 years, his account is *not* the best place to learn about the ecology of fish ponds. But the primary object of the book is not to be up-to-the-minute; quite the contrary—a certain timelessness pervades these pages, and Izaak Walton's comments on *Eisenia foetida* are as valid today as when he wrote them.

Not the least attractive feature of the book are the many woodcuts, twenty of them full page, by Watkins-Pitchford.

GAIRDNER MOMENT

BIRDS IN THE GARDEN *And How to Attract Them. By Margaret McKenny; introduction by Clyde Fisher. The University of Minnesota Press, Minneapolis.* $5.00. xviii + 349 pp. + 48 plates. (1939); 1946.

Nature lovers who desire to attract birds to their gardens will profit by the information that is provided in this book. Directions are given for planning a small or a large garden, with advice on the best trees, shrubs, and flowers to select for their attractiveness to birds. In addition, the plants are listed at the end of the book with parallel columns containing the species of birds most likely to make use of them. This section has been subdivided into geographical areas to ensure selection of plants suited to the varied climatic conditions. Considerable information as to supplementary diets for feeding boxes and shelves is supplied. Since birds may also be attracted by providing suitable nesting sites, bird houses to satisfy many species are described.

The remainder of the book is filled with what may be called bird-lore and will be of interest only to the amateur. There are several scattered statements that are either incorrect, incomplete, or inconsistent. It seems that if so much antagonism is to be heaped upon man as the upsetter of the delicate balance of nature, then the statement that "we want the migrants as well as the permanent residents to stay with us as long as possible" does not follow the precepts outlined elsewhere. Delaying migration may constitute disastrous interference. Loose statements, such as the one (cited from Rowan's work) that increasing the photoperiod increases the production of sex hormones, may cause no great harm in a book of this sort. On the other hand, advising the amateur to take careful notes to provide information of real value is rather irritating, since no further instruction in this is given. Beginners want to know what kind of notes to take, what to look for, what is of value, etc. More details of this type would have been most worthwhile.

This volume is a reprint without change of an earlier

edition. The color plates are taken from Roberts' *Birds of Minnesota*, and the photographs are from various sources. There is an index, a list of references, and an alphabetical list of descriptions of birds to be found in the garden. Anyone interested in creating a garden sanctuary should find all the data needed in this attractively printed volume.

HENRI C. SEIBERT

LIFE HISTORIES OF NORTH AMERICAN JAYS, CROWS, AND TITMICE. *Order Passeriformes. Smithsonian Institution, United States National Museum Bulletin 191. By Arthur Cleveland Bent. U. S. Government Printing Office, Washington, D. C.* $1.75 (paper). xii + 495 pp. + 68 plates. 1946.

After a lapse of five years, the fifteenth in the series of Bent's publications has finally appeared. Although the manuscript had been completed as far back as 1941, the war delayed actual publication until this year, and only information of great importance was added during the intervening years.

The present volume includes two families, the Corvidae (ravens, crows, jays, magpies) and the Paridae (titmice, chickadees, verdins, bushtits). To those not acquainted with the series, each species of bird receives an account that includes all the known and available information on its nesting, eggs, young, plumage, food, behavior, voice, field marks, enemies, and distribution. In the treatment of geographic races, "an attempt has been made to give as full a life history as possible of the best known subspecies of each species and to avoid duplication by writing briefly of the others and giving only the characters of the subspecies, its range, and any habits peculiar to it."

Since so much information is not available elsewhere in any one place, it is no wonder that bird students are always eager whenever a new volume of this series appears, and that the available copies are soon exhausted.

HENRI C. SEIBERT

ANIMALS OF THE WOODS. *True Nature Series, Book 1.*
GRAY SQUIRREL. *True Nature Series, Book 2.*
SNAPPING TURTLE. *True Nature Series, Book 3.*
WATER BIRDS. *True Nature Series, Book 4.*
BLACK BEAR TWINS. *True Nature Series, Book 5.*
THREE LITTLE KITTENS. *True Nature Series, Book 6.*
PRIDE THE SADDLE HORSE. *True Nature Series, Book 7.*
SHEP THE FARM DOG. *True Nature Series, Book 8.*
GOATS AND KIDS. *True Nature Series, Book 9.*
ADVENTURES OF BUNNY RABBIT. *True Nature Series, Book 10.*
ANIMALS OF THE FARM. *True Nature Series, Book 11.*
ELEPHANTS. *True Nature Series, Book 12. Encyclopaedia Britannica Picture Stories. Encyclopaedia Britannica Press, Chicago and New York.* 50 cents each (paper). 40 pp. each; ill. 1946.

These twelve books each consist of series of full-page photographs illustrating the life and habits of the animals on the farm and in the woods. Simply, yet refreshingly done, they provide a welcome relief from the deluge of fanciful children's books now available. Nor are the books without attraction to a more adult audience, for the artistry of the photographic work raises them above any particular age group. A simple text accompanies each photograph, but the parent or teacher should be able to improvise without difficulty to meet the needs of the immediate audience. Only a single inaccuracy was noted: the home of the squirrel as illustrated in the last photograph of Vol. 2 is certainly a venerable pine and not "an old oak tree."

C. P. SWANSON

ON THE ANATOMY AND CLASSIFICATION OF THE DASYURIDAE (MARSUPIALIA). *Results of the Archbold Expeditions. Number 56. Bulletin of the American Museum of Natural History, Volume 88, Article 3. By G. H. H. Tate. American Museum of Natural History, New York.* 70 cents (paper). Pp. 97–156. 1947.

This study is based not only upon the large group of dasyures collected by the Archbold Expedition, but also upon other material secured by H. C. Raven and by Gabriele Neuhäuser. The first part of the paper deals with anatomical, evolutionary, phylogenetic, and distributional aspects of the family Dasyuridae. The second part is wholly taxonomic.

As one of the results of his study, the author concludes that the genus *Thylacinus*, first placed in a separate subfamily (Thylacininae) by Bensley in 1903, should be reunited with the subfamily Phascogalinae. This would reduce the number of dasyure subfamilies to two—the Phascogalinae and the Dasyurinae.

MAMMALS OF EASTERN ASIA. *The Pacific World Series. By G. H. H. Tate. The Macmillan Company, New York.* $4.00. xvi + 366 pp.; ill. 1947.

This book supplies an up-to-date, authoritative, yet semi-popular catalogue of the mammals living in the vast region from northeastern Siberia through Manchuria, China, Burma, and Indo-China to the Malay Peninsula, and including Sakhalin, Japan, and Formosa. For each species there are given very brief diagnostic characters, the geographical range and notes on habits—

as far as known, and that is not very much. Though most of the mammals of Eastern Asia can be enumerated with a general description of their size, coat color and teeth, far too little is yet known concerning all their significant anatomical characters, their full life histories, their detailed distribution, prevalence, variability, etc. The author, naturally, merely presents some of the essentials of available knowledge, but, in attempting to be brief, he sometimes becomes unduly vague. To state, e.g., that the slow lorises are "round-headed, virtually tailless Lemurs with the eyes large . . . the ears small . . . the limbs short . . . the fur very dense and soft . . . " supplies no more precise and useful information than does the advertisement of some merchandise.

In the systematic description of East Asiatic mammals the rodents occupy by far the most space; they are followed in this respect by the carnivores, bats, and even-toed ungulates. Considerably less space is required for the listing of insectivores and of primates, while all the remaining orders (Dermoptera, Cetacea, Lagomorpha, Proboscidea, Sirenia, and Perissodactyla) have been dealt with in very brief sections, each being represented by a comparatively few forms.

Two brief introductory chapters discuss "What is a Mammal?" and "The Home Territories of Eastern Asiatic Mammals." Both chapters are well-balanced essays, the first being quite elementary, but the second, on faunal areas, containing much information known only to specialists. The 79 pen-and-ink text-figures form a specially noteworthy addition to this small volume; all are good, and many are excellent. There is no bibliography, but there is a glossary for the layman and a serviceable index. This is one of the *Pacific World Series* of publications, which has to its credit a number of other reliable and informative, semi-popular books.

A. H. SCHULTZ

MAMMALS OF CALIFORNIA.

By Lloyd Glenn Ingles. Stanford University Press, Stanford University. $4.00. xx + 258 pp. + 42 plates. 1947.

The author of this eminently satisfactory volume has studied mammals for many years. Mammals are evidently his absorbing hobby, so that he has learned to know their habits and habitats from enthusiastic fieldwork and their characters from devoted research in museums and libraries. His book is carefully prepared, well written, excellently printed, and most useful to students of North American mammals, whether expert or amateur.

With its life zones ranging from sea level to above timberline, California is the home of a great variety of mammals, adapted to widely differing environments. These animals are dealt with in systematic order with simple, yet readily usable keys for their identification, clear maps of distribution, well-chosen facts about their habits, food, enemies, etc., diagrams of their tracks, and many remarkably fine photographs. Subspecies or geographic races have not been considered in this work, which is primarily intended for "the student, for the aspiring naturalist, and for all others who want a better acquaintance with and knowledge of the interesting mammals of California." The book includes accounts of 193 species occurring in California, the largest number of which belong to the order of rodents. Not only the essential, established facts have been presented, but it is also indicated throughout the volume how much information is still unavailable and how many problems remain to be investigated. The opening paragraph of the Introduction contains the claim that: "Today in most of the land regions of California there are many more individual mammals than there are birds, reptiles and amphibians combined." Having no right to doubt such a generalization, the reviewer can merely wish for detailed census data in support of this interesting statement. The exceptionally well illustrated appendix on "How to collect and make up study skins" will be welcomed by beginners and can be thoroughly recommended by professionals.

A. H. SCHULTZ

THE MAMMALS OF VIRGINIA. *An Account of the Furred Animals of Land and Sea Known to Exist in This Commonwealth with a List of Fossil Mammals from Virginia. By John Wendell Bailey. Published by the author, 27 Willway Road, Richmond, Virginia.* $5.00. xvi + 416 pp.; ill. 1946.

It must be mentioned, to comment on the subtitle, that a considerable part of this book deals with Cetacea which are not usually called "furred animals." Otherwise the title is exceptionally accurate, inasmuch as domesticated mammals and even man himself are included in this account of Virginia mammals. Guinea pigs, e.g., are discussed like any wild mammals, since they are found in Virginia as pets and are kept for "medicinal purposes." Of man it is stated that, among other things, he is "helpless at birth and develops slowly, becoming sexually mature at about twelve to fifteen years of age. Mammae two and thorasically (sic) placed." The single species for man is divided "into five races, varying greatly in physical and mental qualities: Caucasian, American Indian, Negro, Asiatic, and Malayan." The frontispiece shows the author himself, and the final conclusion in large capital letters claims: "Man is the only animal that drinks when he is not thirsty and makes love the year 'round." Ignoring the International Rules for Zoological Nomenclature, the name *Equus caballus assinus* is bestowed upon the noble mule. The chapter on Habits and Habitats of

Modern Mammals contains such novel generalizations as the following: "The larger species are usually more numerous in the temperate zones"; "most of the smaller mammals have learned to keep out of the way of their larger enemies" and "the tails of arboreal squirrels act as air brakes if they happen to fall from the tree" (it is not clear whether the tails or the squirrels fall off). In chapter X the startling assertion is made that "the number, size and shape of the teeth are always constant in each species." The subfamily Caninae is repeatedly called "Canniae." But enough has already been mentioned to indicate that this is not a volume which can take its place among the many recent, scholarly works on North American mammals. Nonetheless, the book is informative and useful in regard to a great many factual details. The bibliography of 768 titles contains far more than have been used for the text and, being arranged alphabetically by authors' names, is of strictly limited value.

A. H. SCHULTZ

ANIMAL TALES. *An Anthology of Animal Literature of All Countries.*

Compiled and annotated by Ivan T. Sanderson. Alfred A. Knopf, New York. $5.00. xviii + 511 + xiv pp. 1946.

Here is a wonderful book for the naturalist's armchair reading. The selections range from fantastic animal fiction to straight natural history, providing variety and insight not only into the lives of the animal protagonists but also into those of the human beings who observed them. Sanderson has made an excellent choice, limiting himself not only through the wish to balance factual description and anecdote with realistic and fantastic fiction, but also by undertaking to secure a world-wide geographic representation. The thirty-one selections thus carry one from the uplands of Guinea across Mauretania and the Mediterranean into Europe; thence, by way of the Arctic, to North America, Central America, and South America; through the Antarctic to Australia, the East Indies, Japan, Siberia, China, and India; finally completing the circuit through Persia, Russia, Egypt, East and South Africa to the Congo Basin. Here and there an oceanic side-excursion is added for good measure. Each tale or account is prefaced by a geographical and ecological introduction of the setting (has Sanderson really been to all these places?) and a biographical note about the particular author.

Perhaps the highest praise that can be rendered such a book is to say that, like the reviewer, probably every reader will meet here, along with familiar friends, with many more new and enchanting works to which he will hurry for fuller acquaintance at the first opportunity. The animals selected include: the Colobus monkey, fennec, scorpion, deer, rat, reindeer, walrus, beaver, black bear, fishes of the abysmal depths, eagle, wolf, quetzal, jaguar, vicuna, vizchacha, whale, koala, birds of paradise, Japanese monkey, mammoth, panda, yak, Indian elephant, gazelle, crane, cat, lion, penguin, dog, and chimpanzee.

The book is handsomely illustrated with full-page block-prints of each of the animal characters, the prints having been made by Sanderson himself. The format of the book is outstanding, marred only by the strange fact that on many pages the lines of type are bowed.

BENTLEY GLASS

ECONOMIC ZOOLOGY

THE COMING OF THE POND FISHES. *An Account of the Introduction of Certain Spiny-Rayed Fishes, and Other Exotic Species, into the Waters of the Lower Columbia River Region and the Pacific Coast States.*

By Ben Hur Lampman; illustrated by Ralph Penrose Lee. Binfords & Mort, Portland. $2.50. xii + 177 pp. 1946.

The story of the introduction of fishes on the Pacific Coast has been told several times in the austere pages of the Reports and Bulletins of the U. S. Bureau of Fisheries and the publications of various state conservation departments, but this is the first time the whole story has been written for the fisherman, the man most interested in the fishes concerned. Writing in a rambling but entertaining style, the author has managed to get a surprising amount of information into his short book, and unlike many popularizers, he has read the original sources with care and digested them well.

The book is principally concerned with the introduction of spiny-rayed fishes and catfish into Oregon waters and with the men who introduced them; but it covers California and Washington introductions adequately. The much maligned carp receives two chapters, one of them devoted to ways and means of making it edible; and the amusing story of the coming of the bullfrog to Oregon is also included. The author is not content to include history alone, but has retold some of the Indian myths about the coming of salmon and trout to the Columbia. There is a good index.

JOEL W. HEDGPETH

RAISING TURKEYS, *Ducks, Geese, Game Birds. McGraw-Hill Rural Activities Series.*

By Morley A. Jull. McGraw-Hill Book Company, New York and London. $2.80. xii + 467 pp.; ill. 1947.

Vocational agriculture students, other farm folk and poultrymen will find this concise compilation instruc-

tive. The activities discussed are named in sequence at the beginning of each chapter. A point by point summary appears at each chapter's end. Reiteration should fix these topics in the reader's mind.

Of the book's 451 pages, 310 are devoted to a presentation of the available facts on efficient turkey production and marketing. The remainder consists of brief summaries of factual knowledge, spliced with lore, about ducks, geese, guineas, pigeons, peafowl, and game birds. Emphasis is properly placed on breeding, feeding, and management practices which help to minimize the amount of feed required to produce unit product, since feed is the largest cost item in production.

The presentation of facts is supplemented by dicta based on the author's very broad acquaintance with all phases of the poultry industry. Only occasionally do these dicta reflect disputable opinion in fields where available facts are insufficient, e.g.: "If it is not possible for you to sell your turkeys direct to consumers, the next most profitable marketing channel for most turkey growers is to sell through a cooperative which dresses and sells your turkeys for you" (pp. 231–232).

Obvious errors are infrequent—the statement "Poults lacking in vigor, poults with improperly healed vents, and poults that are otherwise defective . . . " (p. 95) may be one. How are vents injured and what is proper in the healing of vents?

The paper is of war-time quality, and the many otherwise excellent photographic illustrations are poorly printed.

T. C. BYERLY

ANIMAL GROWTH AND DEVELOPMENT

LABORATORY MANUAL FOR EMBRYOLOGY. *Third Edition.*

By Theodore W. Torrey. Published by the author, Department of Zoology, Indiana University, Bloomington. $2.00 (paper). 100 pp.; ill. 1946.

This is a neat, clearly written, and well organized little manual designed professedly with the pre-medical student in mind. Perhaps for that reason, the emphasis is entirely on the chick and the 10 mm. pig. Amphibia, *Amphioxus*, and echinoderms are covered in a page each, and directions for working from living material have been altogether omitted. Serial sections and whole mounts of the chick and pig are employed in the usual way, with explicit directions for examination and making drawings. There are 16 well-chosen illustrations to help elucidate difficult anatomical relationships.

The feature that primarily distinguishes this manual from all others is the constant use made of Long and Burlingame's superb *Stereoscopic Atlas of the Chick*. The author has devised an ingenious scheme whereby each student "rents" a set from the University bookstore. It seems worth trying. Another noteworthy feature is that in the second half of the manual the later stages of development are taken up not by species but by systems and organs from a comparative point of view.

Undoubtedly the student who works with this manual in hand will end with a thoroughly competent knowledge of the developmental anatomy of the chick and pig. The next edition should have a table of contents, if not an index.

GAIRDNER MOMENT

THE CHILD FROM FIVE TO TEN.

By Arnold Gesell and Frances L. Ilg, in collaboration with Louise Bates Ames and Glenna E. Bullis. Harper & Brothers, New York and London. $4.00. xiv + 475 pp. 1946.

In this extremely readable book, Arnold Gesell and his co-author continue the research in child development which has already made 'Gesell' a household word in most educated families today. The authors have undertaken the monumental task of defining and describing the objective developmental changes which take place in children at each age level from five to ten. They are careful, however, to remind the reader frequently that growth is, after all, an individual process and that the composite 5-6-7-8- or 9-year-old depicted in this book can only be considered a caricature of any particular child.

The volume is divided into three parts, each beautifully organized, clearly written, and interlarded with such a simple, tolerant philosophy that the reader not only can learn specific items about the grade-school youngster but also may absorb a point of view of understanding and appreciation for the child's growth experiences. Part One is a general orientation to the study. Part Two presents cross-sectional pictures of the behavior typical of the five ages under consideration. On the basis that the second five years follow and are dependent on growth processes already begun in the first five, the authors have very helpfully appended short cross-sectional sketches of the first four years as well. The individual chapters in this section begin with a chatty 'behavior profile' of the particular age. Then the authors break the profile down into ten major fields of behavior, turn on the high power lens, so to speak, and describe in detail each major trend. These 'maturity traits,' as the authors call them, are (1) motor characteristics, (2) personal hygiene, (3) emotional expression, (4) fears and dreams, (5) self and sex, (6) interpersonal relations, (7) play and pastimes, (8) school life, (9) ethical sense, and (10) philosophic outlook. As if these comprehensive and intelligently presented portraits were not enough, Part Three gives the longitudinal sections in which the maturity traits are fol-

lowed from early infancy to ten years. The result of all this painstaking effort and thorough study is a most revealing three-dimensional panorama of the growth gradients in grade-school children.

While this book is far from a simple collection and grouping of observed facts, the authors refrain from hypothesizing about the deep psychological import of their material. Any asides are given on the concrete objective level of advice for the special handling of typical problems, suggestions of educational methods to utilize particular developmental areas, and reassurances to the reader that apparent regressions of behavior are really often consolidations of gains. This veering away from psychiatric abstractions and professional jargon opens the book to a much wider audience.

The Child from Five to Ten is to be wholeheartedly recommended as an important reference work for anyone interested in children. It should be required reading for teachers. Intelligent parents, pediatricians, and child psychiatrists will find much useful and thought-provoking material in this book. It is even possible that statesmen and economists in this troubled world might profit by a consideration of the implications herein, for, as the authors state in their "Philosophic Postscript," "The intrinsic charm and goodness of childhood still constitute the best guarantee of the further perfectibility of mankind"—the roots of a generation which may be led to avoid another war are in the five- to ten-year-olds of today.

By way of postscript it should be remarked that this book has an unusually attractive format. The printing is clear and well-spaced, chapter headings are interesting, the few charts are simple and legible, and typographical errors are practically non-existent. This gracious physical setting further enhances the book's general appeal.

HELEN HEWITT ARTHUR

ANIMAL MORPHOLOGY

LABORATORY STUDIES IN COMPARATIVE VERTEBRATE ANATOMY. *Second Edition.*

By Theodore W. Torrey. Published by the author, Department of Zoology, Indiana University, Bloomington. $2.00 (paper). 67 pp.; ill.

Those who want a dissection manual written in semi-outline style with clear-cut, succinct descriptions and directions should find this one well suited to their needs. As is only right in a course in comparative anatomy, the material, except for an introductory section on Ammocoetes, is presented by systems rather than by animals. The initial section on skeletons is by far the longest, as it should be, but the others are not lacking in completeness. In contrast to most manuals, the material here on the mammal is fitted to the rat, except for the heart and brain, where the sheep is used, and for the skeleton, where the familiar cat is retained. *Necturus* represents the Amphibia, and the dogfish the elasmobranchs. *Amia* is used for the dermatocranium.

The details are competently handled. The external carotid in the lower vertebrates is ventral, where it belongs. Diagrams are introduced where, and only where, a student really needs them. The directions are sufficiently complete and properly seriated to enable a student to do a good job working independently. At the same time, minute directions of the "cook-book" variety are purposely avoided, e.g., the precavals of the rat are described but without any mention of the surprising fact that one swings posterior to the heart.

The present reviewer questions the wisdom of entirely omitting the muscles. They possess considerable interest for students and afford an excellent opportunity to teach something both of the techniques of dissection and of the theories of comparative anatomy. The reviewer also missed any mention of *Amphioxus*, but this may be mere sentiment for auld lang syne. In any case, the work on Ammocoetes accomplishes much the same thing as a study of *Amphioxus*, and without a knowledge of the larval cyclostomes a great part of the meaning of *Amphioxus* is lost anyway.

GAIRDNER MOMENT

FROM HEAD TO FOOT: *Our Bodies and How They Work. A Young World Book.*

By Alex Novikoff; illustrated by Seymour Nydorf. International Publishers, New York. $2.00. 96 pp. 1946.

Alex Novikoff, who wrote so outstanding a book on evolution for the ten- to fourteen-year-olds a year ago (*Climbing Our Family Tree*, cf. Q. R. B. 21: 75. 1946), has now written an equally good companion volume. It is illustrated with the same sort of colored and black-and-white sketches, done with considerable humor. The style is perfectly suited to its readers' ages, moving rapidly and graphically yet clearly from question to historical experiment to explanation. There is no talking down to the youngsters. They are given a solid, well-balanced meal, from the Geiger counter and radioactive tracers to conditioned reflexes and intelligence. Cells and tissues; digestion and nutrition; respiration; circulation; the blood, including the role of the plasma, the blood groups, Rh and all, the antibodies and immunity; the hormones and chemical coordination; excretion; sex determination; sex differences in anatomy and physiology; the growth of the embryo; the sense organs; the nervous system, learning and social organization—these are some of the topics briefly but accurately considered. It couldn't be done? The book is its own spokesman. Once again, a nomination for the *best* children's book of the year!

BENTLEY GLASS

CRANIOMETRY OF AMBRYM ISLAND. *Fieldiana: Anthropology, Volume 37, Number 1.*

By Wilfrid D. Hambly. Chicago Natural History Museum, Chicago. $2.75 (paper). viii + 150 pp. + 4 charts + 30 plates. 1946.

Ambrym Island is one of the New Hebrides archipelago, inhabited by Melanesians. This report is a thorough craniometrical analysis of 31 skulls of this racial stock. It includes the usual measurements, indices, cranial capacities, contour drawings, discussions of variability and sex differences, with numerous accompanying tables and good illustrations. Comparisons are made with other Melanesian groups. There is consideration of Australian, Negro, and Polynesian traits in Ambrym skulls. It is concluded that the latter "are strongly Australoid, somewhat less strongly Negroid, and that throughout Australian, Melanesian, and even Polynesian series, there are impressive Negroid homologies. These may be traceable far back in time and place to a proto-Negroid ancestry . . ."

THE ANATOMY OF THE NERVOUS SYSTEM: *Its Development and Function. Eighth Edition.*

By Stephen Walter Ranson; revised by Sam Lillard Clark. W. B. Saunders Company, Philadelphia and London. $6.50. x + 532 pp.; ill. 1947.

This, the first new edition since the death of Ranson, appears under the able editorship of S. L. Clark. Basically, the book remains unaltered, but it has undergone considerable revision. Some of this has involved a reassembling of material calculated to aid the student; thus the gross descriptive anatomy, formerly scattered throughout the book, has been collected into one section. The chapters dealing with reflexes and with clinical aspects of the nervous system have been greatly improved by rearrangement and by the addition of new material. The term "sympathetic," used in previous editions to embrace the entire visceral motor system, has been replaced by "autonomic"; and the name "sympathetic" itself is restricted to one of the gross divisions of the autonomic system. This is in accord with current usage of these terms. The chapter on the cerebral cortex has received much needed attention, but still is not up to date in certain respects. Clark has accomplished an excellent job in his difficult task of first revision, and the book remains unquestionably among the foremost texts in its field.

W. L. STRAUS JR.

RETINAL STRUCTURE AND COLOUR VISION: *A Restatement and an Hypothesis.*

By E. N. Willmer. Cambridge, at the University Press; The Macmillan Company, New York. $4.50. xii + 231 pp. + 7 plates; text ill. 1946.

Retinal Structure and Colour Vision can best be described as an essay in visual theory. Willmer is a histologist by profession, and, like others of his calling, he has been troubled by the fact that current theories of color vision require the postulation of specialized cells for which the histologist can find no evidence. In this essay, he has investigated the possibility of accounting for the available data without such assumptions. More exactly, Willmer has tried to see *to what extent* it is possible to interpret the data in terms of rods and cones alone; for he admits freely throughout the book that a two-component theory leaves much to be desired and that it cannot be validated until much more information has been gathered.

The author shows a truly remarkable grasp of visual literature outside the field of retinal structure. He feels so much at home in the psychological, chemical, and electrophysiological areas that he does not hesitate to combine, replot, and speculate about data from these fields. The essay becomes a sort of game. The author and the reader agree to assume that only two different types of retinal cell exist and then proceed to see what sorts of interrelations between those types might account for the available facts. Each set of data gives rise to some sort of hypothesis, and independently collected facts are then called in to test the deductions.

No one would say that these hypotheses are ever completely substantiated, and the author himself is most cautious about interpretations. On the other hand, the comparative success of the method goes far beyond what this reviewer, at least, would ever have predicted for it.

No short review can do justice to the closely reasoned argument or to the nature of the interrelations that Willmer finds to support his thesis. No doubt each reader will find his own agreements and disagreements with the method. Yet certainly this is a book that will be stimulating and enjoyable to everyone interested in visual theory. No study of vision so refreshingly original or so full of suggestions for investigation has appeared for many years.

To the limited audience for which it is intended, this work is unreservedly recommended. The Cambridge University Press and their American representatives are to be congratulated for making it available.

W. C. H. PRENTICE

ANIMAL PHYSIOLOGY

ANNUAL REVIEW OF PHYSIOLOGY. *Volume IX.*

Edited by Victor E. Hall, Jefferson M. Crismon, and Arthur C. Giese. Annual Reviews and American Physiological Society, Stanford University P.O., California. $6.00. viii + 736 pp. 1947.

The present volume marks the inauguration of a new editorial staff and the reappearance of contributions from reviewers outside the United States. The present volume includes the following articles and contributors: Growth, Stanley P. Reimann; Developmental Physiology, Albert Tyler; Reproduction, G. van Wagenen; Metabolic Functions of the Endocrine Glands, F. D. W. Lukens; The Physiology of Supporting Tissue, P. D. F. Murray; Muscle, Fritz Buchthal; Exercise, Peter V. Karponich; The Visceral Functions of the Nervous System, W. R. Ingram; Digestive System, Harry Greengard; Kidney, William Dock; Peripheral Circulation, Carl J. Wiggers; Heart, S. Rodbard and L. N. Katz; Derivatives of Blood Plasma, Dwight J. Mulford; Blood Gas Transport, D. B. Dill and W. H. Forbes; Water Metabolism, Edward F. Adolph; Physiological Effects of Heat and Cold, A. P. Gagge and L. P. Herrington; The Respiratory System, Hayden C. Nicholson; Nerve and Synaptic Conduction, Frédéric Bremer; Bioelectric Potentials in the Nervous System and in Muscle, Harry Grundfest; Electrical Activity of the Brain, Margaret A. Lennox and William G. Lennox; The Somatic Functions of the Central Nervous System, Clinton N. Woolsey; Special Senses, Cutaneous Sensation, F. K. Sanders; The Experimental Neurosis, H. S. Liddell; Permeability, W. Wilbrandt; Physiological Aspects of Genetics, M. R. Irwin; Defense Mechanisms, William C. Boyd and Saul Malkiel; Pharmacology, C. C. Pfeiffer and E. R. Loew.

W. D. McELROY

ENDOCRINE FUNCTION OF THE HYPOPHYSIS.

By Harry B. Friedgood; edited by Henry A. Christian. Oxford University Press, New York. $4.50. iv + 236 pp. + 5 pp.; ill. 1946.

This monograph is primarily intended for clinicians. The histology and physiology of the pituitary gland is extremely complicated, and the clinician needs some guidance in order to apply this knowledge to the diagnosis and treatment of pituitary diseases. Friedgood has been for a long time an outstanding investigator in this field. He has succeeded in giving a comprehensive review of the anatomy and physiology of the pituitary gland. It is very fortunate that the author has included phylogenetic viewpoints, which are so often neglected by physicians. The phylogenetic history of the chorioidal cerebral glands is discussed at some length, and this discussion should prove to be very stimulating to further research in the field.

One must disagree with the author on some minor points in the discussion of the differential diagnosis of disorders of growth. Friedgood states that the dwarfed skeleton retains childlike proportions in both pituitary dwarfism and cretinism. In my own experience the proportions are infantile only in cretinism, giving the cretin the appearance of a much younger child. In pituitary dwarfism, on the other hand, the skeletal proportions correspond to the chronological age of the patient. Friedgood states further that, in so far as the bones are concerned, the only differential point between hypophysial and hypothyroid dwarfism lies in the x-ray appearance of the shaft of the long bones. But the occurrence of irregularly formed epiphysial centers in cretinism (epiphysial dysgenesis), as described by Wilkins, is a valuable aid in differential diagnosis.

The bibliography is excellent and includes many important but little known papers. The book is to be warmly recommended to all students of pituitary physiology and pituitary disease.

WALTER FLEISCHMANN

YOUR EYES.

By Sidney A. Fox. Garden City Publishing Company, Garden City, New York. $1.00. viii + 191 + viii pp. + 2 plates; text ill. 1946.

A reprint of an excellent book for the layman, previously reviewed, Q. R. B. 20: 97. 1945.

HUMAN FACTORS IN AIR TRANSPORT DESIGN.

By Ross A. McFarland. McGraw-Hill Book Company, New York and London. $6.00. xx + 670 pp.; text ill. 1946.

Engineers and aircraft designers are becoming increasingly aware that the interaction of human and physical variables in flight is of fundamental importance in the operation of aircraft. No matter how much engineering talent has gone into the development of the mechanical aspects of the machine alone, an aircraft is safe and dependable only if the pilot can control it easily and efficiently. From the passenger's standpoint, an aircraft is comfortable only if it does not place undue stresses on his sensory and adjustive mechanisms.

There has been published recently a number of books supporting and elaborating this general thesis. This one, however, is outstanding. It is outstanding because it is comprehensive and authoritative in this field, and because it shows how an enormous number of basic biological research findings can be applied in the efficient design of a particular kind of man-machine system. In the book—and this review as well—biological research includes broadly medical, physiological, psychological, anthropological, and related fields of research.

Some idea of the breadth of this book may be conveyed by a listing of the main chapter headings: high altitude operations and pressurized cabins; the control of ventilation, temperature, and humidity; the control of insects and air-borne diseases; carbon monoxide and

other noxious gases; the control of noise in the cabins of aircraft; the control of vibration in air transport planes; acceleration, motion, and flight performance; the cockpit and control cabin of air transports; passenger accommodations on air transport planes; and the prevention of aircraft accidents.

A listing of chapter headings cannot indicate, however, how thoroughly each of these topics is treated. In every chapter the author has reviewed the basic biological data relevant to the problem, has shown how these data can be applied to problems of flight, and has concluded with a list of specific recommendations for the aircraft designer. The amount of information presented is amazing, especially since much of it comes from unpublished reports from Army, Navy, and industrial laboratories. Even though this book is oriented toward aircraft, much of the material should be of interest to industrial engineers generally. The sections on temperature, humidity, noise, vibration, noxious gases, control mechanisms and dial legibility, for example, are excellent. The recommendations in these sections might apply equally well to working environments anywhere.

A. CHAPANIS

BIOCHEMISTRY

INTRODUCTION À LA BIOCHIMIE GÉNÉRALE. *Fourth Edition.*

By Marcel Florkin. Masson & Cie., Paris; Editions Desoer, Liege. 760 fr. (paper). 371 pp. + 4 tables. 1946.

In some ways this textbook on biochemistry is a refreshing improvement on the more orthodox texts we customarily see here in America. It covers essentially the same material, with chapters on the chemistry of the lipids, carbohydrates, and proteins. It differs primarily in its attempt, which is quite often very successful, to introduce a more biological approach in discussing the chemical properties of the substances found in living things.

There is a very interesting chapter on chemical homologies, organized so as to emphasize similarities and relationships among the vitamins and hormones as well as carcinogenic agents.

The section on metabolism again illustrates the wide biological interest of the author. Thus, instead of concentrating attention on mammalian metabolism, he adequately describes our knowledge of both the autotrophic and heterotrophic types of metabolic activity. Their comparison, both catabolically and anabolically, with respect to various kinds of compounds proves to be very illuminating. This is then followed by a stimulating discussion of the probable evolution of the various types of metabolism discussed. The book concludes with a description of the cycles of the elements in the biosphere.

Some problems have not been adequately discussed. Among these may be mentioned nucleic acids and photosynthesis. In large part this must be due to the unavailability of some of the more recent literature. The book is well indexed. However, the illustrations leave much to be desired. In general, it may be said that students of biology will find much of value and nterest in this volume.

S. SPIEGELMAN

ADVANCES IN ENZYMOLOGY *and Related Subjects of Biochemistry. Volume VI.*

Edited by F. F. Nord and C. H. Werkman. Interscience Publishers, New York. $5.50. viii + 563 pp. 1946.

The sixth volume of *Advances in Enzymology* is an improvement over the previous issue, both in the quality and quantity of material covered. The editors are to be congratulated for their success in securing contributions from some of the foremost European workers. Some of the topics covered will be of particular interest to biologists who are concerned with general cellular physiology and the energetics of cellular metabolism.

There is an excellent chapter by E. F. Gale of Cambridge on the bacterial amino acid decarboxylases, a subject to which the author has contributed much significant information. D. W. Wooley reviews some of the rapidly growing literature on biological antagonisms between structurally related compounds. He has chosen to emphasize the more pharmacological aspects of these problems. This is a viewpoint which has not received very extensive attention, but one which obviously has many implications for future research in animal physiology.

Engelhardt summarizes the remarkable investigations by himself and his colleagues of the muscle protein, myosin, and its enzymatic properties. This chapter is of particular value, since it presents an approach by one of its originators which may well lead to the solution of how the cell can transform chemical into mechanical energy. Lipmann presents, as usual, a thoughtful and original essay which will undoubtedly stimulate much fruitful thinking on the part of the reader. He concerns himself principally with the role and properties of acetyl phosphate in metabolism, both catabolic and anabolic.

Recent years have witnessed rapid advances in our knowledge of assimilatory processes, gained mainly from the study of micro-organisms. This field is thoroughly and competently reviewed by C. E. Clifton. Other topics covered include the chemical changes in the harvested tobacco leaf, the action of the amylases, as well as a survey of their application in technology.

Tocopherol interrelationships are surveyed by Hickman and Harris.

The only departure from the high standard of scholarship and competence is in the article by M. G. Sevag entitled "Enzyme problems in relation to chemotherapy, 'adaptation,' mutation, resistance, and immunity." The aforesaid title indicates the extent of the topics covered, if not the understanding of the author. The opening paragraphs, as well as the rest of the 94-page article, exhibit the author's genius for getting himself involved in sophomoric semantic difficulties of his own creation. Sevag finds it very difficult to separate fact from assumption. Thus he blandly, on the first page of his article, tosses out a statement that "antigens function as catalysts" as if it were an undisputed fact. He forgets that it is an assumption of his own which is far from being accepted even as a working hypothesis by most active workers in the field of immunology. His confusion is also reflected in the inaccuracy with which he reports some of the results (e.g., Stephenson's work on hydrogenlyase). In addition, he fails to consider experimental data which would deny the validity of his arguments (e.g., v. Euler's work on the apoenzymatic nature of adaptation to galactose by yeast).

In the opinion of this reviewer the placing of question marks (pp. 67, 71) does not constitute a contribution towards the clarification of the mechanism of a reaction, especially when the author forgets that they exist in the text. Furthermore, the substitution of the words "building up processes" for "enzymatic adaptation" does not constitute a solution to the problem of why cells can vary their enzymatic constitution in response to substrate. Such verbal gymnastics do not, despite Sevag's faith, solve the mechanisms of natural phenomena or do away with the need of finding their solutions.

S. SPIEGELMAN

PRACTICAL PHYSIOLOGICAL CHEMISTRY FOR MEDICAL STUDENTS. *Third Edition Revised.*

By G. M. Wishart, D. P. Cuthbertson, and J. W. Chambers. John Smith & Son, Glasgow. 7s. viii + 131 pp. + 2 plates. 1945.

Both experiments and the small amount of theoretical explanation are pitched at an elementary level.

H. R. CATCHPOLE

BIOCHEMISTRY OF CANCER.

By Jesse P. Greenstein. Academic Press, New York. $7.80. viii + 389 pp.; ill. 1947.

It is fortunate that at a time when so much money and effort are being directed toward a solution of the problem of cancer Greenstein's book becomes available. For the many workers in the field of oncology the author brings together a large mass of experimental data and presents it clearly and simply. The present volume includes much more than the biochemistry of cancer. After an introduction to the oncological sciences, the general phenomena and taxonomy of cancer are discussed in Chapter II. The next two chapters consider the problem of cancer induction. Chapter III is concerned with the extrinsic factors (coal tar derivatives, azo dyes, radiation, etc.) and Chapter IV with the intrinsic factors in cancer induction. In the three following chapters the numerous studies concerned with the control of tumor induction and tumor growth are discussed. These include the chemotherapeutic, endocrinological, and nutritional studies. Chapters VIII and IX, which make up approximately two-thirds of the book, are concerned with the chemistry of tumors and with the chemistry of the tumor-bearing host. It is in the last two chapters that the numerous studies dealing with the enzymology of normal and cancerous tissues are covered. The final chapter presents a general picture of the present status of the cancer problem.

The book contains an author and subject index, 941 references, 39 figures, and 54 tables.

W. D. MCELROY

STEROID CHAINS AS COMPONENTS OF PROTEIN AND CARBON MOLECULES.

By Theodore van Schelven. Kosmos Publishing Company, Amsterdam (Holland). $3.00 (paper). 64 pp. + 11 plates. 1946.

The author rather promptly forsook a field of scientific speculation, which the title of this book might suggest, and entered a more ample region of esoterica into which the reviewer, at least, was not disposed to venture far.

H. R. CATCHPOLE

MICROBIOLOGY

BACTERIAL CHEMISTRY AND PHYSIOLOGY.

By John Roger Porter. John Wiley & Sons, New York; Chapman & Hall, London. $12.00. x + 1073 pp. + 4 charts. 1946.

This is the first comprehensive review of the subject which has been published in more than a decade. During that time tremendous interest in microbial chemistry has been manifested by a rapidly increasing volume of literature, the writers of which have carried out research along a variety of lines of investigation.

Partly as a result of this, numerous conflicting opinions have been expressed—based, for example, on different types of data—and probably as many lacunae still remain in our knowledge at the present time.

The author has made no attempt at critical evaluation of his material, and it is perhaps debatable whether or not this is a weakness in the book. Because of the present state of information and the confusing array of scientific data available, it may be some time before more than the main lines of understanding become clearly delineated.

The text is well organized and it is concise, lucid, and comprehensive. Among the subjects covered are physiological processes, properties, and composition of bacteria, the effects of physical and chemical agents, the metabolism of carbon and nitrogen compounds, and microbial fermentations used in industry. Recent studies of growth factors and enzymes are discussed in considerable detail. Rererences are full and up to date. There are many charts and tables, and an organism index as well as a subject one. The format is excellent.

The book is described in the preface as an outgrowth of material assembled for instruction of students in bacterial physiology. As such it may be highly recommended. Although of course not designed for use by specialists, it should prove convenient and valuable as a general basic reference book for investigators concerned directly or indirectly with microbiological problems.

HARRIETTE VERA

MICROBIOLOGY AND EPIDEMIOLOGY: *Being a Volume in the Series "Achievements of Soviet Medicine in the Patriotic War."*

Edited by E. B. Babsky, I. G. Kochergin, and V. V. Parin. Translated by H. P. Fox. Medical Publications, London. 15s. 158 pp. 1945.

One of the most consistent and menacing problems to face any nation at war is that of disease control, not only among its armed forces, but among the home population as well. The successes, as well as the failures of the Russian medical profession, in dealing with the epidemiological problems which accompanied the recent war with Germany, are adequately discussed in the 15 papers comprising this volume. Special attention has been directed to the diagnosis, prophylaxis, and treatment of such war-time scourges as typhus, dysentery, tetanus, cholera, gas-gangrene and tularemia. Because of the impact of war conditions of diet, housing, and the movement of large population groups, many prevailing ideas regarding the pathogenicity of various microorganisms have had to be revised, and many established research findings have had to be further elaborated to meet emergency needs. As a result of war-time advances in microbiology and epidemiology, the general level of health of the Russian people will undoubtedly be maintained at a higher plane than was ever possible prior to the war.

A majority of the papers carry an abundance of tabular material. There is a table of contents, but no index is provided.

B. AUBREY SCHNEIDER

PRINCIPLES OF MICROBIOLOGY. *Second Edition.*

By Francis E. Colien. The C. V. Mosby Company, St. Louis. $3.50. 530 pp. + 25 plates. 1946.

The second edition of this fine textbook for students of nursing (1st ed., reviewed Q. R. B. 17: 82. 1942) shows the marks of added wartime emphasis on tropical diseases. The methods of laboratory diagnosis for these have been added. Considerable revision and addition has been made to a number of chapters to bring the discussions up to date. The use of penicillin and the sulfa drugs is discussed; additional culture media are given; and two new chapters, on the Collection and Handling of Material for Bacterial Examination, and on Microbiology in Relation to Food, have been added. Although the color plates are an attractive feature of the book, the half-tone illustrations are very poorly reproduced.

BENTLEY GLASS

MICROBIOLOGY AND PATHOLOGY FOR NURSES. *Second Edition.*

By Mary Elizabeth Morse, Martin Frobisher, Jr., and Coleman B. Rabin. W. B. Saunders Company, Philadelphia and London. $3.50. xii + 758 pp. + 1 plate; ill. 1946.

The second edition of this popular text has been prepared with the view of providing student nurses with a combined course in bacteriology and pathology. A comprehensive body of well illustrated materials has been selected and presented in an effort to give the student a concise summary of the general principles of microbiology and pathology as well as the application of these principles to the everyday activities of the practising nurse.

The most recent developments in the fields of microscopy, immunization, and disease-controlling drugs have been presented with clarity and simplicity. The series of 28 laboratory exercises covers a sufficiently wide variety of technical activities to give the student a working knowledge of the practical application of the more important clinical procedures. In the field of nursing education, this volume will undoubtedly

maintain its well established record of usefulness. A glossary and a detailed index are appended.

B. AUBREY SCHNEIDER

SÉNESCENCE ET ÉVOLUTION: *Cycle du Bacille Tuberculeux. Bibliothèque Scientifique.*

By Léon Grigoraki; preface by J. Guiart. Paul Lechevalier, Paris. 200 fr. (paper). 174 pp. + 6 plates. 1945.

Grigoraki is a medical mycologist trained in the old and glorious tradition of French dermatology. His main contribution appears to have been in the field of classification of dermatophytes, with clarification of a number of misinterpreted complex life-cycles in these parasitic fungi. This work is discussed in the first part of this book, written in a bitterly polemical and naively autobiographical style. There follows a section containing one of the least convincing and least documented among the various "original" descriptions of the life-cycle and sexuality of the tubercle bacillus that have thus far been proposed. The author then proceeds to erect his findings on the pleomorphism of aging dermatophytes to the dignity of a general law of biology, rambling unbridled through paleontology, genetics, evolution and what not. With naive self-assurance he disposes of entire fields of biology with which he is obviously unfamiliar. The following example (p. 159) is to be found in a discussion of induced gene mutations in *Drosophila* (supposedly due to inflammation!):

"Nous savons que les rayons X déterminent un état inflammatoire sur les tissues et nous savons que toute inflammation comporte en prémier degré une vasodilatation, ce qui a pu accélerer le processus d'assimilation de l'animal et par conséquent sa sénescence."

The discovery of vasodilation in Diptera would warrant a book in itself!

This book may find its way into some undiscriminating library, but, if ever taken down from the shelf, is likely to be quickly replaced with a shudder.

S. E. LURIA

PARASITOLOGY

TREPONEMATOSIS.

By Ellis H. Hudson; edited by Henry A. Christian. Oxford University Press, New York. $2.50. iv + 114 pp. + 2 pp. 1946.

This book is a reprint from a section in the well-known Oxford Loose-Leaf Medicine. The authors have boiled down an endless array of historical facts and published bits of confusion until there now remains only the probable truth.

With a minimum of effort the reader may become versed in the history and etiology of one of the antiquities of disease in mankind. From the syphilologist to the layman, from the clergyman to the historian this synopsis of "Treponematosis" will prove of value.

Do you know that syphilis did not originate in America, that syphilis, yaws, pinta, bejel, sibbens, irkintja and others are all different manifestations of the same thing? The authors substantiate such statements with published evidence, both pro and con, and arrive at logical conclusions which are best summarized in the one word of the title, "Treponematosis."

The book is adequately indexed and has a bibliography of 134 publications.

GEORGE A. SPENDLOVE

STUDIES ON ACARUS SCABIEI AND SCABIES. *Acta Dermato-venereologica, Supplementum XIV (Volume XXVI).*

By Björn Heilesen. Rosenkilde & Bagger, Copenhagen. D.Cr.16.-(paper). 370 pp. + 14 plates; ill. 1946.

This book contains a wealth of detailed information concerning the itch mite, *Acarus (Sarcoptes) scabiei*. Part I deals with the historical background, whereas Part II describes the author's own researches on the external and internal anatomy, life cycle, and general biology of the mite together with illustrations and descriptions of the pathogenesis and histology of the scabietic eruption, modes of transmission, and the efficiency of scabies remedies.

Only the briefest review of the historical aspects of the itch mite and of scabies can be given, since this section covers almost a hundred pages. The hypothesis that scabies was of animal origin originated in Italy in the 17th century, but it was not until after 1834 that the mite was finally proven to be the cause of scabies and that significant progress was initiated on the morphology and biology of the itch mite. Most of the details in the developmental cycle have been described since 1900. The literature contains much conflicting information regarding the structure of the capitulum, extremities, and genitals. A review of previous investigations as to the sensitization of patients to *Acarus scabiei* and as to eosinophilia in scabietic patients produces conflicting information. Also, varying information regarding the length of time the itch mite may survive outside the host indicates a need for further investigation, in order to learn the risks of transmission. Previous work done on the effectiveness of scabies remedies against the parasite and its egg is reviewed.

From Part II it is evident that the author has given much effort to the study of the internal and external

anatomy of the itch mite in its several postembryonic stages. Embryological details have not been covered. Special emphasis is given to the capitulum, the appendages, the distribution of hairs, and the genitals. The study of internal structures emphasizes the lack of identifiable salivary glands in the mite, and only a limited description of the alimentary tract and reproductive organs is given.

A summary of the life cycle of the female itch mite is given in the following stages by hours: egg, 72-96; larva, 72; first nymph, 72-96; second nymph, 72-96; adult, oviposits about 48 hours after copulation. The cycle covers from 14 to 17 days from egg to egg. The male lacks the second nymphal stage and develops in from 9 to 10 days. Copulation takes place in the burrow.

In studies made on the biology of the itch mite, it was observed that larvae, nymphs, and males show the greatest inclination to burrow into the epidermis as soon as they are placed on the skin. Often small, short burrows are dug, barely long enough to hold the mite. Further experiments show that all these stages move readily to another place on the skin. They move both in the daytime and at night. The mites have to burrow into the skin in order to obtain protection and food. Molting occurs in the burrows. The burrow of the ovigerous female produces the most characteristic symptom of scabies. This burrow appears as a narrow, slightly raised line on the surface of the skin. The female usually remains in its burrow. The time required for the female to bore into the skin is about 30 minutes. The female mite always seems to burrow in folds in the skin. It prefers deeper furrows and places where cracks occur in the epidermis.

It has not been possible by means of extracts of female itch mites to demonstrate sensitization of scabies patients to the parasite. The experimental scabies infections seem to indicate that most frequently itching occurs early in reinfected persons. The itching incubation periods found in patients with an initial infection may, however, also be very short. In addition to the effect of the parasites in producing the scabies eruption, scratching by the patient also contributes to the formation. Eosinophilia occurs particularly in patients with infections of long duration, with severe eruptions, and many parasites.

Histological investigations show that the itch mite may bore the capitulum far down into the mucous layer of the skin, where intra- and inter-cellular edema and formation of vesicles may result. Infections are most frequently transmitted by occupying the same bed with a scabietic patient, but they may also occur during dancing and ordinary intimate contact between members of a family. It was found that in patients with large mite populations, the course of treatment usually required two applications of acaricidal substances, the second treatment being given 4 to 5 days after the first treatment.

The bibliography in this work includes almost 200 citations. The appendix, which consists of 200 pages, includes the details of numerous experiments performed by the author and much clinical information regarding the mode of transmission and the itching incubation period, based on 274 scabies patients.

F. EARLE LYMAN

MALLOPHAGA AND ANOPLURA. *The Zoology of Iceland, Volume III, Part 42.*

By Chr. Overgaard. Ejnar Munksgaard, Copenhagen and Reykjavik. Kr. 2.10 (paper). 22 pp. 1942.

The author briefly outlines the previous work published on these groups from Iceland. He adds 29 species not hitherto known from Iceland. In the Mallophaga he lists 47 species, with brief notes on their general distribution, the specific localities where they have been taken in Iceland, and their hosts; in the Anoplura only the three species known from man are recorded. This is followed by a list of hosts with their known Mallophagan and Anopluran parasites and by brief notes on the distribution of Mallophaga.

ROBERT MATHESON

FLEAS OF WESTERN NORTH AMERICA: *Their Relation to the Public Health.*

By Clarence Andresen Hubbard. The Iowa State College Press, Ames. $6.00. x + 533 pp. + 5 plates; ill. 1947.

The author has undertaken the difficult task of preparing a monograph of the fleas of North America west of the 100th meridian. In this area he recognizes 66 genera and 236 species and subspecies. The first few chapters give a brief account of the students of fleas, a discussion of fleas in relation to disease, the techniques of collecting and the preparation of fleas for study, and a brief note on their structure.

The main body of the work (Part II, pp. 43–390) deals with the taxonomy of fleas. Here we find two classifications of the order: that of Oudemans, who divided the order into two suborders; and that more generally followed by recent workers, who arrange the genera directly into families, as proposed by Jordan and more recently by Ewing and Fox (1943). Unfortunately, the author apparently adopts the arrangement of the families as given by Ewing and Fox, for he copies their key to the families. Yet, in the following paragraphs he dissents from this grouping and continues to follow the arrangement of the genera into families as suggested to him by Karl Jordan. However, he does not present a key to the families accord-

ing to this scheme. This is unfortunate, for the beginning student will certainly have difficulty in placing at least six genera. Five of these are placed in the family Hystrichopsyllidae whereas Ewing and Fox place them in the Dolichopsyllidae; one genus, placed by Ewing and Fox in the Pulicidae, here appears in the Hystrichopsyllidae.

Following the discussion of the general classification, each family is fully described, with keys to the genera and species. The genotype is indicated for each genus. Each species is briefly described and its essential details well illustrated, along with full notes on its hosts and distribution. In addition there are notes on the life history, relation to disease, and methods of control, wherever these are known. The newer techniques for flea control are apparently omitted or unknown to the author.

In this work the author establishes one new genus, *Thrassoides*, with *Thrassis aridis* Prince (1944) as type. Though many references are made to the work of Ewing and Fox (1943), yet the author does not accept their interpretation of generic concepts. The genera *Diamanus* and *Opisocrostis* are retained and not regarded as subgenera of *Oropsylla;* the genera *Megabothris, Malaraeus,* and *Pleochaetis* stand as distinct and are not regarded as subgenera of *Trichopsylla* (this genus is not referred to by the author); the genus *Monopsyllus* Kolenati is used, though Ewing and Fox consider this genus not to be represented in North America.

In closing the section on taxonomy, Hubbard presents a condensed table showing the known distribution and the number of species known from each state and Canadian province west of the 100th meridian. He also indicates the type locality of the species. Based on the work of I. Fox (1940), he presents a similar chart for the fleas of the eastern United States.

Part III consists of an excellent account of the hosts of western fleas, with many detailed notes that will be invaluable for the general reader as well as the specialist.

The monograph is certainly to be highly commended for its vast amount of detailed information, based so much on personal collecting and study throughout a vast region. The publishers are to be congratulated on the use of excellent paper, clear illustrations, and substantial binding. Though some errors appear from time to time, yet on the whole the book should furnish a permanent basis for all students who are interested in fleas and their relation to human welfare.

ROBERT MATHESON

HEALTH AND DISEASE

CHEMOTHERAPY: *Yesterday, To-day, and To-morrow. The Linacre Lecture Delivered at Cambridge on May 6, 1946.*

By Sir Alexander Fleming. Cambridge, at the University Press; The Macmillan Company, New York. 50 cents (paper). 39 pp. + 2 plates; ill. 1946.

Fleming has reviewed the subject of the chemotherapy of bacterial infections in a manner that will provide every reader with a clear picture of this fascinating field of scientific investigation. Without engaging in a discussion of the complicated theories of the mechanism of action of the antibacterial agents, the author illustrates the nature of the problems that have called for solution since the time of Paul Ehrlich and his "Therapia magna sterilisans." Penicillin, its antecedents, its discovery, its applications and properties are described by the discoverer. The future of the other antibiotics, gramicidin, tyrothricin, and streptomycin, is predicted.

In describing the early development of chemotherapeutic drugs, Fleming has illustrated one of the pitfalls that investigators too often overlook. In 1924 he employed Wright's slide-cell method to show in a certain experiment the toxic action of chemicals on bacteria and leucocytes alike. Normally the body depends upon the leucocytes in the blood to destroy invading organisms. Chemotherapeutic compounds active against bacteria in the culture tube may not necessarily be suitable for the treatment of body infections, especially if the chemical is destructive to leucocytic action. Dilutions of the chemical were made in normal saline, and to these there was added an equal volume of human blood suitably infected with the test bacteria. After incubation of the slides it was observed that normal human blood alone kills about 95 per cent of the organisms. Removal of the leucocytes eliminated this bactericidal power of blood. When the chemical antiseptics in use at that time were introduced, there was a range of concentration where the chemical destroyed the leucocytes without interfering with the growth of the bacteria and actually increased their growth. Fleming comments upon this as the most important series of experiments he has ever done, and he goes on to describe how they influenced the discoveries that were to come. To say more would be answering the mystery in the first chapter and spoiling the story; no one should do that, especially when it has been related so well. Who is there who could have told the tale better?

C. JELLEFF CARR

PENICILLIN: *Its Practical Application. Edited by Sir Alexander Fleming. The Blakiston Company, Philadelphia.* $7.00. xii + 380 pp.; ill. 1946.

This volume represents the work of 28 specialists writing under the editorial supervision of Alexander Fleming. Intended for the general practitioner of medicine

and for the surgeon, the authors have described the latest techniques, dosage forms, and various fields of successful use of penicillin. The first of the two sections into which the book is divided is devoted to the history and development, manufacture and chemistry, pharmacy, pharmacology, and bacteriological control of penicillin. The second section is clinical in character, and in it the consideration of special medical procedures is stressed.

In addition to the purely medical sections there are chapters on the use of penicillin in dental and veterinary surgery.

This is not a textbook but a series of independent contributions by the various authors, giving their views on the use of penicillin in infections in specific regions of the body. There results the inevitable duplication. Differences of opinion regarding dosage and methods of use is indicative of the youthful character of antibiotic therapy. As indicated in the preface, another year or two will see a revision of many of the statements made in this edition.

As a timely compilation of this field of antibiotic therapy the book will be useful for the physician, teacher, and scientist.

C. JELLEFF CARR

THE POCKET BOOK OF BABY AND CHILD CARE.

By Benjamin Spock. Pocket Books, New York. 25 cents (paper). viii + 518 pp. 1946.

This book will quickly take its place as the best of its kind. Its scope is far greater than its title indicates. In a simple, quite conversational style (well matched by the winning humor of the sketches which illustrate the book), the author deals not only with the superficial problems of child care, but presents a completely rounded picture of the physical and mental growth and development of infants and children, right through the period of adolescence. Every element of their feeding, training, cleanliness, and the prevention and care of illness has been considered. The very best part of the book is its treatment of the psychological problems of development and the growth of the child's personality. Common sense, modern pediatric skill and knowledge, and sound psychology have combined to produce an outstanding handbook for parents.

This edition, complete in every respect, appeared just a month after the trade edition, entitled *The Common Sense Book of Baby and Child Care*, under the imprint of a different publisher.

BENTLEY GLASS

RENAL HYPERTENSION.

By Eduardo Braun-Menéndez, Juan Carlos Fasciolo, Luis F. Leloir, Juan M. Muñoz, and Alberto C. Taquini. Translated by Lewis Dexter. Charles C. Thomas, Springfield, Illinois. $6.75. xxx + 451 pp. + 1 plate. 1946.

The translator's preface states that the authors' "method of presentation consists of critically reviewing practically all pertinent literature concerned with renal hypertension and of offering their interpretation." In any field as controversial as this, the reader may well disagree with the authors' interpretations, since many problems, as they point out, are still unsettled, a statement with which all workers in hypertension and arteriosclerosis will agree. The prologue of Bernado A. Haussay initiates a tone of emotional and controversial quality which pervades and detracts from the character of the book.

This volume should nevertheless be interesting and stimulating to those interested in the field of experimental hypertension. The authors' knowledge of the chemistry of renin because of extensive experience "permits them to describe their own valuable contributions and to discuss the problem in a critical fashion." Because of their investigative enthusiasm or a lack of clinical experience the authors appear to be led into the quick-sand of assuming that renal ischemia underlies all or almost all hypertension. Much otherwise adequately presented material thus becomes warped. A better balanced presentation would have been made if a control series had been run or a familiarity with the extensive studies of others (e.g., E. T. Bell's 12,000 autopsies) had been shown.

The premise of renal ischemia is rocked by the knowledge that hypertension may develop in persons whose renal vascular lesions are no greater than those to be found in non-hypertensive control individuals and that conversely, thirty per cent of the controls whose intimal disease is severe do not have hypertension unless there is atrophy of the cortex.

Anatomic change cannot be both cause and effect. The facts that extensive arteriosclerosis with decreased blood flow is commonly accompanied by normal or low blood pressure, and that individuals with anemia, cyanosis, or congenital disorders do not have hypertension would have made an interesting discussion by these able investigators.

This subject of human hypertension is confined to 92 pages of superficial discussion. This limits the book in usefulness to the clinician. This volume makes interesting reading, and its extensive bibliography will be a valuable and convenient reference for those working on renal experimental hypertension. The translation is good, misprints are surprisingly rare, and a very high standard of bookmaking has been attained.

M. HERBERT BARKER

EXPERIMENTAL HYPERTENSION. *Being the Results of a Conference on This Subject Held by the Section of Biology of The New York Academy of Sciences, February 9 and 10, 1945, New York City. Special Publications of The New York Academy of Sciences, Volume III.*

By William Goldring, Richard J. Bing, Eduardo Cruz Coke, W. D. Collings, L. W. Donaldson, M. L. Goldberg, Harry Goldblatt, B. Gomberg, Arthur Grollman, C. A. Johnson, Oliver Kamm, Luis F. Leloir, H. Minatoya, W. G. Moss, Eric Ogden, Irvine H. Page, John W. Remington, L. A. Sapirstein, and G. E. Wakerlin. The New York Academy of Sciences, New York. $3.75. x + 179 pp; 1 plate. 1946.

This book is the result of a conference on hypertension held by the Section of Biology of the New York Academy of Sciences in 1945. It would be an almost impossible task to review the papers of so many excellent contributors without writing another book. Fortunately, Irvine H. Page of the Cleveland Clinic has clearly defined the purpose and the importance of this symposium in a short preface. Arterial hypertension, today, is no longer viewed as the hemodynamic response of the blood vessels to aging. Rather, it has come to represent a distinct pathological state initiated and perpetrated by a wide variety of causative factors. Recent work has opened large fields for investigation. The role of the kidneys, the humoral pressor mechanisms, the participation of the nervous and endocrine systems are challenging problems. Essential hypertension is a systemic process which does not fall easily into the domain of the cardiologist, urologist, neurologist, etc. Were there such a discipline as angiology, it might most readily fit into this domain. The investigation of hypertension is now in the state where widespread intellectual and emotional disagreement exists among those concerned with investigating the problem experimentally. However, promising efforts of research are gravely endangered by a lack of even the simplest organization of the scientific defense against what is probably humanity's most lethal enemy. To understand the nature and control of arterial hypertension and arteriosclerosis is one of the greatest objectives of medical research.

The New York Conference is an important milestone on the road toward this objective.

MARTIN GUMPERT

AN INTRODUCTION TO ESSENTIAL HYPERTENSION.

By Richard F. Herndon. Charles C. Thomas, Springfield, Illinois. $2.50. ix + 88 pp. 1946.

This is an excellent study for the medical practitioner, refreshingly short, comprehensive, up to date, and well illustrated. Hypertension is undoubtedly the most frequent and serious abnormality known. It occurs in approximately half the American population over fifty years of age and contributes, according to Herndon, to at least twenty-five per cent of their deaths. The incidence of hypertension is steadily growing. We do not know why. We know very little about the etiology and the mechanism, the physiology and pathology of this disease, but what we do know at present is well explained and well reviewed by the author, and his summary of thousands of confusing observations and reports will contribute much to a better understanding of the important syndrome. The opinion of this experienced physician on the treatment of hypertension is, of course, of general interest. According to Herndon, there is no treatment yet known that will cure or arrest hypertension. All therapy is palliative in nature. The importance of rest, diet, and psychotherapy is stressed. "Frequent, quiet, pleasant vacations cannot be overestimated." Tobacco should be used in strict moderation if at all. Most patients are over- rather than undermedicated. Physicians are too prone to prescribe when they should be content to counsel. Of drugs, the nitrites are probably the safest and most satisfactory for the direct treatment of hypertension, especially sodium nitrite. The fashionable bilateral section of the splanchnic nerves with sympathetic ganglionectomy leads to a prolonged, but not permanent, fall in blood pressure. The period of benefit averages between two and seven years. In the author's opinion surgical procedures do not answer the need for a specific treatment. However, by carefully studying the individual problem, we can give our patients very real help and prolong their active, useful lives. The valuable little book ends with a quotation from Thornton Wilder: "There is one thing greater than curing a malady and that is accepting a malady and sharing its acceptance."

MARTIN GUMPERT

A TEXT-BOOK OF PATHOLOGY. *Sixth Edition.*

By E. T. Bell. Contributors: B. J. Clawson and J. S. McCartney. Lea & Febiger, Philadelphia. $10.00. 910 pp. + 2 plates; text ill. 1947.

The sixth edition of this standard textbook of pathology (5th ed., reviewed Q. R. B. 19: 351. 1944) has been brought up to date, and the vitamin deficiencies and tropical diseases, in particular, have received greater attention. (The relation of folic acid to sprue, however, has not gotten in yet.) The number of illustrations has been increased more than 10 per cent. Biologists will find this a good reference on most of the subjects included.

ALLERGY *in Theory and Practice.*

By Robert A. Cooke in association with Horace S.

Baldwin, Robert Chobot, R. Clark Grove, Joseph Harkavy, Selian Hebald, Michael Heidelberger, Paul Klemperer, Louis Schwartz, W. C. Spain, Dudley D. Stetson, Albert Vander Veer, Mathew Walzer, and Margaret B. Strauss. W. B. Saunders Company, Philadelphia and London. $8.00. xxvi + 572 pp.; ill. 1947.

This volume is a comprehensive presentation of the many scientific and clinical problems which the physician encounters in the field of allergy. In the foreword, the author states that "instruction in allergy has lagged in spite of its steadily increasing importance as evidenced by its basic significance and broad applicability in the theory and practice of medicine and its various subdivisions." The reviewer heartily endorses this statement. It is indeed gratifying to have in our libraries a book that so thoroughly and accurately covers this special field.

The work is a compilation of formal lectures which the author and the "New York Group," sponsored by the American College of Physicians, have so ably presented during the past few years to postgraduate students of allergy. With few exceptions, the contributors have been students of the author and have worked under his direction for many years; naturally, his conservative judgment is reflected in the writing of these associates.

The lectures are divided into nine sections, with an appendix. Within these nine sections, all fundamental aspects of allergy are discussed at length. Although there are differences of opinion concerning the mechanism of the "skin sensitizing antibody" and the "inhibiting antibody," the author gives an appraisal that is fair to each group of investigators.

Section I, devoted to the pathologic-anatomic aspects of allergy, emphasizes the role of allergy in disease. Although this section is brief, the discussion on the immunochemistry of allergens and antibodies is inclusive and instructive.

Sections II and III concern allergy of the respiratory tract. To an exceptional degree, this clinical discussion is concise and helpful. Unfortunately, the arrangement is not chronologic; for example, non-infective and infective asthma are discussed before hayfever and rhinitis are presented, although the latter two conditions, in clinical practice no less important than the former, are often the forerunners of the more serious complaints. The part relating to the differential diagnosis of bronchial asthma is condensed to five pages, so that the information presented is little more than an outline. More importance should have been ascribed to this portion of the book, whether the publication is for the postgraduate student or for the undergraduate student.

Section IV, Allergy of the Skin, is a compilation of lectures by the author, by Louis Schwartz, and by Dudley D. Stetson. Allergic dermatitis is so important in chemical industries, even in the less hazardous occupations, that too much emphasis cannot be placed on this manifestation. These lectures adequately discuss the mechanism of allergic dermatitis, the occurrence of various types of dermatitis, and the treatment of the different clinical problems that are encountered.

Less understood allergic problems are discussed in Section V (Allergy of the Nervous System) and in Section VI (Allergy of the Cardiovascular System). The lectures in Section VII relate to other specialties: Allergy of the Digestive System; Allergy of the Eye; Allergy of Infancy and Childhood. The discussion of gastro-intestinal allergy is conservative, and is in complete agreement with the experience of the reviewer. However, there are other physicians, also interested chiefly in allergy, who will consider this section too conservative, or even inadequate.

In Section VIII there are a number of subjects which have been given special consideration by the author: for example, Bacterial Allergy in Relation to Diseases of Allergy; Inhalants; Foods and Drugs in Relation to Diseases of Allergy; and finally, Physical Allergy. Many of the unusual reactions of these allergens are clearly explained in this series of lectures. Section IX should be especially helpful to the laboratory assistant. The discussion of skin testing, of the preparation and standardization of extracts, and of laboratory procedures should prove particularly helpful to those physicians and biologists who contemplate the special field of allergy.

A statement to which the reviewer must take exception is the one by the author (p. 148) that he does not concur in the belief that opium and its derivatives should never be used in asthma. That many asthmatic patients have died following the injection of a small dose of morphine must be well known to the author and to other physicians with training in allergy. Such death was due to sudden paralysis of a fatigued respiratory center in a patient who had been struggling for oxygen over a period of hours. Because such reactions cannot be foretold, I must emphasize that the use of morphine in asthma is too dangerous a procedure.

In the appendix the author mentions, as if it were an after-thought, "a revival of interest in psychic and nervous factors in relation to disease—so-called psychosomatic medicine." Only two short paragraphs are devoted to this important subject, and one is given the impression that the author is not impressed with the importance of nervous factors in relation to allergic diseases. Of course, psychic factors cannot produce an allergic state, but pseudo-allergic states would not be diagnosed as "allergic," if specialists in the field of allergy were better psychiatrists. This is true especially in the study of patients suspected of an allergy to foods.

In general, this is an excellent presentation, discussing and clarifying the theory, the clinical manifestations, and the treatment of allergic diseases. This

volume will be most enlightening to all who contemplate the practice of Internal Medicine, as well as to biologists interested in allergy.

LESLIE N. GAY

THE DIAGNOSIS AND TREATMENT OF BRONCHIAL ASTHMA.

By Leslie N. Gay, with a foreword by Warfield T. Longcope. The Williams & Wilkins Company, Baltimore. $5.00. x + 334 pp. + 4 plates; ill. 1946.

The majority of volumes upon bronchial asthma have an opening chapter upon the immunochemistry of allergic conditions, the histamine theory, and the antibody reaction. It is, therefore, a somewhat novel, but practical idea for Gay to preface his work upon asthma with a chapter upon the physiology of normal respiration and the asthmatic state. The reader is thus introduced directly and immediately to the difficult problems connected with this respiratory disease.

Considerable emphasis has been placed, in the chapters upon the etiology and upon the treatment of asthma, on the pollen factors so often found important. Less is mentioned about non-seasonal inhalant factors such as dusts, animal emanations, vegetables, lints and powders, foods or drugs. Two decades ago such would not have been the case, but Gay is obviously convinced that now there is need for more widespread knowledge of the fundamental importance of pollen sensitization and its presence in the obscure and complicated asthmatic problems. The practice of the specialist and of the specialty clinic contains progressively fewer of those simple cases of bronchial asthma which are due to contact with easily avoided excitants, such as animal danders or single foods. Even the lay individual, without benefit of medical advice, has learned often to identify and to cope successfully with such types.

The chapter upon pathology is quite comprehensive, containing a wealth of data from the Johns Hopkins' Hospital archives. Autopsy findings, both macroscopic and microscopic, are given in detail. An impressive amount of space has been devoted to the problem of the diagnosis of bronchial asthma, and the procedures necessary to differentiate it from other forms of breathlessness are discussed. These will prove to be of great importance to all those interested in this stubborn disease.

At least one-third of the volume is devoted to a discussion of the therapy of the various forms of bronchial asthma. Descriptions of the types of treatment are given with emphasis upon those which are initiated by or complicated by a bacterial sensitization. There are detailed specifications of the methods of handling patients with an analysis of the formulae of the various antigenic mixtures which are prepared for hypodermic injections. In a chapter upon psychomatic disturbances of the asthmatic, the impact upon the asthmatic patient of his personal problems is considered at length.

The most outstanding characteristic of this volume is the fact that it will convince the reader that it is the result of the writer's personal experiences with asthmatic problems over the course of many years. It is filled with a wealth of detailed case reports, which furnish much helpful and practical information to the careful reader. Controversial subjects are largely ignored. In sum, by recording the observations and experiences he has gathered throughout a lifetime of active practice in this special field, Leslie N. Gay has produced a book of great value to both student and practitioner. He is to be congratulated upon this achievement.

W. C. SPAIN

CANCER CAN BE CURED.

By Alfred J. Cantor. Didier, New York. $2.50. xii + 175 pp. 1946.

The increasing interest in cancer on the part of the general public has resulted in a demand for a carefully prepared volume setting forth the facts about this dread disease in such a manner that they can be understood, appreciated, and used in dealing with any problem involving cancer. Recently, numerous attempts have been made to fill this demand, but all to date (including the present volume) have been notoriously unsuccessful.

Cantor writes with a breezy sensationalism which will be obnoxious to a large proportion of his intended audience. For example, the reader is asked to repeat before and after grace at each meal, "Vaginal discharge, with or without bleeding, should lead to an immediate internal examination" (p. 40). Again, according to the author, if the reader is uncircumcized, then he is "a full-fledged candidate for the degree of penile cancer" (p. 80). The author's advice to women to nurse their children for the prevention of breast cancer is based on the supposed relationship between breast congestion and breast cancer. This advice is hollow, in view of the fact that the majority of breast cancers occurs in breasts that have never even been subjected to the risk of congestion, i.e., among unmarried, and among childless married women. Cantor does not mention the recently discovered milk-factor in mice which has prompted cautious cancer specialists to advise women from families that have shown an abnormally high incidence of breast cancer, not to nurse their female children because of the possibility of thus transmitting the disease to them. Numerous professional eyebrows will be raised at the author's suggestion that the layman can and should diagnose his own skin cancer. The

author skates on thin ice when he recommends the lavish use of soap and water in the prevention of skin cancer. Fortunately, the relationships between tobacco and cancer are not as clear-cut as the author would have his readers believe.

Although it is agreed that a greater number of cancer cures can be effected only when the general public has been educated away from blind, unreasoning fear of the disease, the average lay reader will find very little in these pages to dispel such a fear.

MEDICAL RESEARCH: *A Symposium.*

Edited by Austin Smith. J. B. Lippincott Company, Philadelphia, London, and Montreal. $5.00. x + 169 pp. + 16 plates. 1946.

The experiences of eight eminent men in the field of medical research have gone into the preparation of this excellent volume. Every phase of medical research, from the training of the prospective investigator through the organization of the modern laboratory and the maintenance of adequate staffs and equipment, to the publishing of reports, has been discussed here with clarity and authority.

The early sections of the work cover the basic principles of research, with special emphasis on the motives, the needs, and the trends in present day medical investigations. The relative advantages and disadvantages of medical research when sponsored and conducted by industrial, governmental, and academic laboratories are discussed thoroughly in the light of comparative costs, freedom of thought and of activity, fundamental versus practical investigations, and the personal satisfaction and advancement of the investigator.

The concluding sections on the publicizing of scientific investigations and on the use of photography in medical research contain a wealth of information applicable to many fields of scientific endeavor. For the medical student or the science graduate student who is interested in the possibilities of medical research as a profession, this work is highly recommended for the purpose of basic orientation. The volume is carefully indexed, and the chapter on photography is colorfully illustrated.

B. AUBREY SCHNEIDER

MEDICAL EDUCATION AND THE CHANGING ORDER. *Studies of the New York Academy of Medicine Committee on Medicine and the Changing Order.*

By Raymond B. Allen. The Commonwealth Fund, New York. $1.50. xviii + 142 pp. 1946.

Raymond B. Allen, former Dean of the Colleges of Dentistry, Medicine, and Pharmacy in the University of Illinois, and now President of the University of Washington, discusses in a most stimulating way the ever real problem of Medical Education. Allen stresses the fact that a good medical education should be based on the study of life in all its aspects, physical, psychological, and social. We know that the medical education of the past has had a tendency to neglect the latter two factors, and that therefore the doctor has often been inadequately prepared for his role in preventive medicine and in society at large. The author rightly stresses the fact that the foundation for a good medical education must be laid long before the pupil reaches the Medical School, and that medical education must go on in a certain sense beyond the granting of the M.D. degree, right up to the time of retirement. The author examines in detail present formal studies of medical education, and makes suggestions as to changes, particularly from the point of view that the future doctor needs to become adaptable to those rapid changes which medicine continually undergoes and is bound to undergo, and that he should be enabled to adapt himself to the medicine not only of today, but also of tomorrow. Allen suggests that clinical studies might start earlier and that the study of basic sciences might be continued into the later years of the curriculum. It is impossible to deal here with all the detailed proposals of the little book. Sometimes it may emphasize too strongly the task of educating future research scientists rather than future practitioners. But otherwise everybody interested in medical education will find it a most substantial, honest, intelligent, and stimulating study.

ERWIN H. ACKERKNECHT

THE DOCTOR RECOMMENDS.

By C. O. Young. Wetzel Publishing Company, Los Angeles. $2.50. 319 pp. 1946.

This book serves as a forceful reminder that publishers should be more careful in accepting manuscripts for publication. To be sure, they should consider the layman's desire to be kept abreast of the developments of medical science, its progress and its problems, but there are both good and poor ways of doing this. The author writes in pure "journalese," with short paragraphs and clipped sentences broken up by numerous subheadings. The whole reads like a poorly edited science section of some small-town weekly. Young is also given to humor, of a variety such as the following, in referring to William Harvey, discoverer of the circulation of the blood: "Harvey, not of Harvey restaurant fame!"

It is a tragedy that a public eager to receive enlightenment concerning modern medicine should be given fare such as this.

E. H. HERRON

PSYCHOLOGY AND ANIMAL BEHAVIOR

A PSYCHOLOGY OF GROWTH. *McGraw-Hill Series in Nursing.*

By Bert I. Beverly. McGraw-Hill Book Company, New York and London. $2.50. xvi + 235 pp. 1947.

This is a rambling discourse on child and adolescent psychology. It is liberally interspersed with helpful hints to parents on how to rear and understand children. It also contains numerous miniature case studies to show that psychological causes frequently underlie behavior problems in children and in adults. The final chapter on "Adults" is a survey of neuroses, psychoses, alcoholism, sexual aberrations, and the like.

This book is apparently the outgrowth of a course in elementary psychology which the author has been teaching for a number of years in a school of nursing. Presumably it is intended as a text for such a course. And it may be that this is the sort of introduction to psychology which our future nurses need. It would hardly qualify, however, as a text for any undergraduate course in a psychology curriculum. There is too little factual material, and the contents are not organized well enough for such a purpose. In any case, the book may be recommended to parents who have not had, and will not have, contact with any other texts on child or general psychology.

A. CHAPANIS

THE NATURE AND CONDITIONS OF LEARNING. *Prentice-Hall, New York Psychology Series.*

By Howard L. Kingsley. Prentice-Hall, New York. $6.00. xvi +579 pp.; ill. 1946.

The usual textbook of educational psychology is concerned with many different topics: emotional development, the measurement of skills and aptitudes, audio-visual aids to teaching, and other psychological aspects of the teacher's daily task. The process of learning as it is viewed by experimental and theoretical psychologists is likely to get perfunctory and often inadequate treatment.

Here is an unusually successful attempt to present basic research on the nature of learning in a guise that will be both attractive and useful to potential teachers. Kingsley has included a mass of laboratory data with the usual collection of classroom-studies, and has synthesized the two kinds of material in a theoretically sound and practically useful text. The author's general orientation is modeled largely on that of Bentley and so may seem strange to many workers in the field of learning, where Bentley's concepts are less familiar than those of other systematists. The treatment of specific experimental studies is, however, sufficiently eclectic to satisfy most readers.

One complaint: the title is at least mildly misleading. This book is, of course, no substitute for Hilgard and Marquis's *Conditioning and Learning* or for McGeoch's *The Psychology of Human Learning.* Kingsley's book is still primarily a textbook in an applied field; it is written for teachers and written with a very practical slant. Nevertheless, it is excellent in delineating learning as a process and in emphasizing the experimental approach as the best way to gain an understanding of that process.

W. C. H. PRENTICE

THE EGO AND THE MECHANISMS OF DEFENCE.

By Anna Freud. Translated from the German by Cecil Baines. International Universities Press, New York. $4.00. x + 196 pp. 1946.

This is the first American edition of an important contribution to psychoanalytic thinking. The original work was translated from the German over ten years ago. However, it has taken the current impetus of an expanding interest in psychoanalysis to make such a work available here. It is to be hoped that this will mark the beginning of American reprints of other classical psychoanalytic papers.

In this work, Anna Freud takes the position that in order to make a thorough analysis of a patient it is essential to understand and evaluate all three psychic levels—the id, the ego, and the super-ego. At one time many analysts apparently felt that it was of value only to uncover the deep unconscious instincts with which a patient was involved—that the ego structure, or conscious, was an area to be penetrated rather than considered. While modern analysts have long ago accepted and developed further Anna Freud's point of view, many psychiatrists and laymen still seem to believe that analysts are intent only on releasing these instinctual urges. Therefore, it is possibly of some general value to have reiterated the more tenable position of analysis in dealing with the total psyche.

The ego is in a key position, as far as analysis is concerned, for only through it can the psychiatrist learn the functioning and the effect of the id and the super-ego on conscious life. It is, then, essential to understand the twists and turns the ego takes to protect itself from the dangerous instinctual drives and to maintain itself in the face of the judgmental super-ego.

After defining the position of the ego and its use as an object per se of analysis, the author elaborates on the methods by which the ego defends itself from internal and external onslaughts. She categorizes nine neurotic defense mechanisms, namely, regression, repression, reaction-formation, isolation, undoing, projection, introjection, turning against the self, and reversal, and mentions a tenth, sublimation, which she indicates as the normal, non-symptom-forming method of defense.

The motives for these ego defense measures are next explored. According to Anna Freud there are three psychic situations which provoke active ego resistance. There is the anxiety imposed on the ego by a severe super-ego or conscience which represents the basis for neuroses in adults. There is the anxiety imposed by a fear of losing a loved object if the instincts are not controlled. This is the basis of many symptom formations in children. Underlying both these, however, is the much more deep-seated and primitive anxiety that the strength of the instincts themselves may actually overwhelm and extinguish the ego that has struggled to differentiate itself, and this eventuality spells psychosis.

The remainder of the book is devoted to elaborating and illustrating her thesis. Because of the author's intensive work with children, her examples are especially engrossing and convincing. Rather than rely for support of her hypotheses on anamnestic data from adults, she builds her points on actual cases of child patients so as to show how defense mechanisms develop. Particularly interesting is the author's illustration of "defense motivated by fear of the strength of the instincts" in which she uses the phenomena of puberty as an example.

This book is not recommended as reading for anyone not oriented in psychoanalysis. It has already an established reputation in analytic circles and is "required reading" for the aspiring young analyst. In this edition Cecil Baines' translation seems to be a very adequate one. Certainly the style is clear and readable, which is a great help in following the author's logical but necessarily somewhat abstract material.

HELEN HEWITT ARTHUR

ALL BUT ME AND THEE. *Psychiatry at the Foxhole Level.* *By Brigadier General Elliot D. Cooke. Infantry Journal Press, Washington.* $2.75. 215 pp. 1946.

All But Me and Thee is the interesting account of a brigadier general's attempt to learn "all about" the problems of Army psychiatry in a relatively short period of time. This assignment would have been a formidable task even for one long familiar with the field, and for a psychiatrically "green" Army officer to have made such inroads toward understanding the many facets of the situation is an accomplishment worthy of much admiration. Combining that capacity with an ability to tell a story results in a very readable book.

The investigation the author carried out took him from the induction lines through training camps and overseas units to various types of redistribution and rehabilitation centers. Of particular interest is the objective account of "tracking down" a shipload of psychopaths and psychoneurotics which were unwittingly sent out of the States. One is impressed with the courtesy General Cooke exhibits in sparing comments about many members of the medical corps he undoubtedly encountered who often were as poorly oriented to neuropsychiatric problems as could possibly be. Although one is disappointed at the amount of disagreement evidenced by the War Department Conference as to what conclusions could be drawn from the data collected, the enormous complexity of the problem is made obvious.

General Cooke's efforts point out well the fact that it is not necessary to have a complete background in medicine to be of considerable use in attacking the problems that confront us in psychiatry.

PAUL H. GRAY

WAR STRESS AND NEUROTIC ILLNESS. *Second Edition. By Abram Kardiner with the collaboration of Herbert Spiegel. Paul B. Hoeber, New York and London.* $4.50. xvi + 428 pp. 1947.

This is a book which should be read by all who are interested in the psychopathology of the neuroses. The author presents his views on the etiology, psychopathology, course, and treatment of the traumatic neuroses. He provides adequate case histories to illustrate his views, and he attempts to link his observations to the problem of the neuroses as a whole.

He concludes that the nucleus of the traumatic neuroses is a relatively amorphous process. "The traumatic event creates excitations beyond the possibility of mastering and inflicts a severe blow to the total ego organization. The activities involved in successful adaptation to the external environment become blocked in their usual outlets" (p. 224). "The symptomatology indicates that the mechanism for action has been injured by contractile or inhibitory processes which are protective in intent" (p. 198). This is the nuclear process, and it may be associated with, or followed by neurotic attempts to adjust to the altered ego organization. These may show the characteristic features of conversion hysteria, obsessive internal formulations, etc.

This concept of traumatic neurosis is based upon a formulation in which emphasis is placed upon the individual (his pattern of organization for action), rather than upon his instinctual mechanisms. Such a formulation is a perfectly reasonable and valid one, and it offers possibilities for the understanding of certain psychiatric reaction types which would not readily be available otherwise. The author summarizes the difference between his own approach and the instructive dynamic Freudian psychology as follows: "The distinguishing feature of Freud's instinct theory is that it is based on a conative-appetitive-striving, rather than a structural principle like sensation or reflex. . . . Hence the conative and qualitative elements were stressed and the structural elements underplayed. . . . That is it was

only the uses to which the (executive) apparatus was to be directed which came into question, but not the apparatus itself. . . . But where the disturbance lies in the complex mechanism of action, it becomes very difficult to describe the phenomena of the traumatic neurosis with the constructs furnished by the libido theory" (p. 254).

The development and integration of normal action systems is discussed at length, together with their breakdown in the face of trauma. These chapters are full of interesting comments but are not always easy to comprehend as a whole, owing to the author's habit of digression, particularly in the midst of his summaries.

The chapters upon the soldier and his job, upon battlefield psychiatry, and upon the treatment of the acute traumatic neuroses are written in collaboration with Herbert Speigel and are first rate.

The basic theme of the book, as indicated, is relatively simple, but there is much in it which is not at all simple and which merits long and careful study.

C. H. ROGERSON

BE GLAD YOU'RE NEUROTIC. *Second revised edition. By Louis E. Bisch. Whittlesey House, McGraw-Hill Book Company, New York and London.* $2.50. x + 230 pp. 1946.

Bisch's book, *Be Glad You're Neurotic*, in which he describes psychiatric treatment as "simple and easy" for the patient, is not only guilty of over-selling psychiatry to the public, but of offering it up in true "medicine show" style.

The belief that Bisch's "being neurotic myself and delighted" should "reassure all the neurotics" borders on the grandiose. However, the reassurance would appear to be threatened when the author confesses to his lack of understanding of the neurosis by declaring: "understand what it means to be neurotic. . . and presto the malady disappears." Among the interesting bits of information brought to light in the book, the following are noteworthy: that "the term psychoneurosis. . . for the most part, has been discarded"; that "neurosis, no matter what the nature, can nowadays be cured"; that "for Loss of Memory. . . the usual physical causes are late hours, insufficient sleep, too little exercise and fresh air, too much alcohol or tobacco, sluggish intestinal elimination"; that "a competent psychiatrist" can foretell a psychosis when an individual is "8, 10, or 12"; that "as a neurotic it may be that all you need is a little glandular adjustment."

With his over-simplifications and dangerous generalizations, a type of talk which all too frequently today increases the average psychiatrist's tasks with a patient exposed to it, our author seems bent on proving his statement that "a neurotic creates more trouble than an epidemic of smallpox."

PAUL H. GRAY

THE MIND AND DEATH OF A GENIUS.

By David Abrahamsen. Columbia University Press, New York. $3.00 xii + 228 pp. + 4 plates. 1946.

Approximately 44 years ago, in the same house where Beethoven had died in Vienna, a young, brilliant Austrian scholar, Otto Weininger, Ph.D., killed himself by shooting himself in the chest. Before he did this, Weininger had published a treatise which could be called psychological and which was entitled *Sex and Character*. The publication of this treatise caused one of the largest furores among scientific circles that had ever been seen in Austria proper. The book was at first received with a good deal of hostility and some indifference, but during the following 30 years it was published 30 different times and has been translated into many foreign languages.

This book was an attempt by Weininger to show the intimate connection between the sex of a person and the character of a person. According to his uncompromisingly double philosophical thoughts, the male represents the positive, productive, and moral principle whereas woman is an absolutely negative, unproductive, and amoral person. Weininger went on to show in his treatise that he believed that a good deal of the troubles of mankind are caused by what is termed by him "bisexuality" and that there must be an admixture of male for good element and female for bad element in every human. The eventual outcome of the person's life depends on which predominates. Weininger then tried to show how men who have primarily a greater proportion of female element are destined to become failures, whereas women who often become proficient in professions such as chemistry, medicine, etc., must have a greater proportion of male element in their bisexual makeup. He therefore advocated total sexual abstinence and even the end of physical life as panaceas against this bi-sexualization of neuroses and psychoses.

Throughout the treatise, there was mixed a good deal of anti-Semitic preaching, a considerable proportion of which was based on the fact that the Jews, as a race, undoubtedly possess a greater proportion of female element in their dualistic constitution. This Weininger held in spite of the fact that he was himself a Jew.

During the preparation of his treatise Weininger was in constant communication with Freud, who discussed the book with many persons and dismissed it as something that could not be taken seriously. On the other hand, the book was hailed as "revolutionary" by many of the leading psychologists of the day.

In the present book, David Abrahamsen tries to show the lay reader what mental anguish Weininger experienced during his short life, and he stresses throughout the book the fact that Weininger was undoubtedly a genius, since he could produce a book like this in the very throes of what appears to have been a schizophrenic breakdown. It is quite apparent, in reading about the life of Otto Weininger, that he evidently

suffered from some delusions of grandeur and apparently believed that he was a reincarnation of the Messiah. Abrahamsen's book is the first attempt to interpret Otto Weininger's book with the aid of modern psychological and psychoanalytical methods.

The author portrays very well the early life of the genius, through its various stages. Weininger was a very precocious child, an unusually gifted adolescent, the son of a tyrannical father who was a famous goldsmith and also an extraordinary musician. On the other hand, the mother was a humble, domestic individual. There can be little doubt from Abrahamsen's discussion of the genius' early life that his father's severity to his mother must have played a great part in forming some of the devastating views of women which Weininger held later. There was also a theory that the young scholar was strongly homosexual, and it is quite apparent in his writings that he strove mightily to suppress these feelings. The author quotes many eminent psychiatrists of the day who, following Weininger's suicide, attempted to make a psychiatric diagnosis of his case. The consensus was that the young man suffered from a manic depressive psychosis with apparently a good deal of schizoid factors underlying the personality structure.

The book is extremely well written. There are very few grammatical errors, and it is easy reading, not laden with heavy psychoanalytic terms. It is simply an exposition of a very unhappy but brilliant man, written in such a manner that it can be readily understood by most people. The author has done a great deal of research and has secured much personal information regarding the unhappy Viennese from Weininger's sister and friends. There was also mention of several communications from Freud in the book. Apparently Abrahamsen attempted to carry out a lengthy correspondence with Freud relating to the underlying psychopathological factors in the case of Weininger, as Freud interpreted them. However, the war interrupted this work.

In summation, this piece of writing is a valuable study and yet another attempt to show that the dividing line between genius and psychosis can be, and often is, a very thin and weak one.

ROBERT MAZER

HUMAN BIOLOGY

MAN THE ANIMAL.

By Raymond Pearl. Principia Press, Bloomington, Indiana. $2.00. xii + 128 pp.; ill. 1946.

This remarkable little volume, the result of a series of lectures delivered under the Patten Foundation at the University of Indiana nearly a decade ago, may well be taken as a landmark in the progress of human biology. The chapters on "Human Longevity" and on "The Numbers of Men," the longest and best in the book, are especially noteworthy for presenting the biostatistics of mankind in a manner that summarizes much of the work of Pearl and his school.

The style is clear and eminently readable. Pearl was a man who exuberated in his subject and was accustomed to enliven it with his own robust humor. In this regard the reader will not be disappointed.

Yet the book is more than a presentation of certain important aspects of the natural history of man, as they appeared a decade ago. It gives a picture of the natural history of a mind, the mind of a man who was one of the world's best known biologists, a founder of journals, and a molder of opinion. If it is necessary to point out that, especially in the opening chapters on the uniqueness of man and in the closing one on patterns for living together, there are many statements open to serious doubt, it must be remembered that to follow the maxim of *nihil nisi bonum*, breathing nothing but praise for the honored dead, would be to render all comment as void of significance as a totalitarian election where everyone is free to vote, so long as he votes *Ja*. Pearl himself would certainly have regarded such vapid praise as emasculated. The truth is plainly that Pearl had that type of mind which ranges through many fields of learning, ancient and modern alike, the type that is synthetic, suggestive, and stimulating rather than skeptical and rigorously logical. It is the prerogative of such minds to compare men to the predacious big cats in one chapter and to a herd of ruminants in another.

What conclusion does he reach? That in the ideal world of the future, as Pearl sees it, "some men would be richer than others, but no man would be either inordinately rich or terribly poor," so allowing us to encourage the greatest possible development of all imaginable kinds of individual differences in every realm of human life.

GAIRDNER MOMENT

ESSAYS ON HISTORIOGRAPHY.

By James C. Malin. Published by the author, 1541 University Drive, Lawrence, Kansas. $2.50 (paper). vi + 188 pp. 1946.

This small monograph contains four essays. The first two, "The Turner-Mackinder Space Concept of History" and "N. S. Shaler on the Frontier Concept and the Grassland," are concerned with two opposing ideas about the role of space in history. Turner is famous for his ideas about the frontier in the shaping of American character, both national and individual. With the passing of the frontier at the opening of the twentieth century, he felt that a new era had arrived, characterized by the concept of closed space. Malin links this type of thinking with that of Sir Halford Mac-

kinder, whose essay on the Heartland of Europe expressed essentially the same philosophy, i.e., the passing of the "open" areas and our entrance into a closed world. This type of thinking Malin contrasts sharply with Shaler's concepts. Shaler also was concerned with the end of the frontier in America, but his thinking turned then to the possibilities of more intensive land use. The end of free land seemed to him less of a fundamental change than it did to Turner.

Both Turner and Shaler are among those great American scholars who are well worth knowing. Turner has had a deep influence on the thinking of American historians and on those people in related disciplines. Malin's essay is useful in showing the growth of Turner's ideas and in reviewing the criticism that has developed around Turner's school of thought. Malin's final conclusion is that Turner's thesis is essentially a single factor explanation of history and suffers from the shortcomings of any single factor explanation. Shaler, on the other hand, emerges as a man of great breadth and insight. His realization of the importance of soils to the welfare of the nation, his view of the future effects of technological developments (including a realization of the possibility of the development of atomic energy) shows him to be a man of most unusual insight. As Malin pictures the two men, it was Shaler who had much the surer grasp of the meaning of the grassland to America and who had the more realistic understanding of the frontier and its processes. Shaler, too, had a more optimistic outlook. He had greater faith in the ability of men to improve their use of the land.

In the essay "Science and Social Theory" Malin has traced the growth of ideas in various sciences. One of the most important things he has found is a revival of the organismic concept of society. This idea, going back at least to Plato, and analyzed and discarded in the nineteenth century, he finds has now been "rediscovered" by the ecologists and seized upon by some of the social scientists and made the basis for justifying a regimented, managed society.

Malin goes on to discuss the present-day threat to pure science. Science, the instrument of the State; science under government control lest it cause depression; the increasing monopoly of scientists and sources by business and government—all tend to end advancement in pure science. Malin maintains that this applies equally to both the physical and social sciences. He notes that our wartime achievements were the result of applying basic science already possessed, and that no new basic discoveries were made. He notes that scientists, frightened by the consequences of their scientific discoveries, are now urging surrender of liberties in a manner that fits exactly into the program of the advocates of a totalitarian world order. Scientists should be interested in Malin's thesis of the interrelations between scientific advance, social and scientific philosophy, and the authoritarian trend.

The essay on "Certainty and History" deals with the proposition that "the historian deals with units of facts, simple combinations of facts, combinations that become increasingly complex, and by successively broadening the horizon, he finds himself face to face ultimately with the problem of First Cause." He points out that somewhere in the series prior to reaching First Cause uncertainty enters. Yet he maintains we must not emphasize the narrow limits of certainty, but rather the common ground of certainty within the limits of probability. Malin feels that a sense of certainty is fundamental to the defense of freedom in a disordered world, and he strives to lay a basis for this certainty by examining the roots of philosophic thought and by indicating lines along which we may move.

GEORGE F. CARTER

THE ANALYSIS OF SOCIAL CHANGE: *Based on Observations in Central Africa.*

By Godfrey and Monica Wilson. Cambridge, at the University Press; The Macmillan Company, New York. $2.25. viii + 177 pp. 1945.

The authors, Godfrey and Monica (Hunter) Wilson, belong to that unequaled group of South African anthropologists whose field work is rightly famous. Feeling that the duties of an anthropologist are not limited to the mere collecting of field data, they have tried, in this little volume, to draw some general conclusions from their rich field experience. Such an effort is most praiseworthy in a period when anthropologists either do not make such synthetic attempts at all, or when their synthesis is based on vague gleanings from psychoanalytic and sociological writings, rather than on their own field work.

After describing briefly the actually painful changes in Central African society, the authors try to reduce these changes to general denominators, the most important of which to them is "change in scale. . . where the intensity of relations in narrower circles is replaced by more widespread relations in larger circles." In culture they always distinguish religious and matter-of-fact aspects, as in the dichotomy of philosophy and science, technique and art, morals and economy. The present disequilibrium of Central African society, which is only part of the disequilibrium of the world, is due to the outrunning in scale of the religious by the material elements of society. The study of the changes in Central African society gives to the authors the occasion for defining the fundamental elements of both primitive and modern societies. Their chapters on the complexity of modern society; its non-magicality (the element of chance is introduced); impersonality; social mobility; autonomy in the narrower and subordination in the wider relations, are to me the finest parts of the book, and belong to the best ever written in anthropology. If racialism,

the main reason for the disequilibrium in Central Africa, but rampant everywhere, is not overcome, "contraction of scale" in society seems inevitable to the authors.

The Wilsons refer to Tylor, Durckheim, Malinowski, and Radcliffe-Brown as the fathers of theoretical anthropology. This choice of authors also clearly indicates their own orientation. Yet they are highly original in their own right. There is no space here for a detailed discussion of minor points of disagreement, particularly as to the appreciation of magic. In any case our conclusions would remain quite the same: this little book, not always easy to read, is one of the best published in many years in the field of anthropology. It is a tragic commentary on its general thesis that one of its authors has already become a victim of the "disequilibrium" of our world. Godfrey Wilson died in service after the book was completed.

ERWIN H. ACKERKNECHT

THE CHRYSANTHEMUM AND THE SWORD: *Patterns of Japanese Culture.*

By Ruth Benedict. Houghton Mifflin Company, Boston. $3.00. viii + 324 pp. 1946.

Under the stimulus of her work with the O. W. I. during the war, Ruth Benedict, the author of *Patterns of Culture*, probably the best known and certainly one of the best American anthropologists living today, has turned this time from analyzing primitive culture to analyzing the far more complicated culture patterns of an old civilization—Japan.

After a short but very enlightening chapter on Japanese psychology during the war, the author discusses the fundamental attitudes of the Japanese, and first of all his limitless adherence to the principle of hierarchy, to "taking one's station." The author very ably illustrates this trait with the history of the Meiji Reform, where, in spite of all the radical changes made, the hierarchical principle was safeguarded.

Taking one's station in life involves innumerable obligations, as from the first cry a human receives services which to render later on in life is the highest virtue. Such obligations exist not only in the case of the Emperor and the parents, where they are practically limitless, but they result from every, even most casual, contact in life. In this sort of obligation is included also the obligation toward one's own name. Offenses have to be paid back just as any other debt; and, if there is no other way, they have to be settled by suicide. The Japanese are educated more by shaming than by force, a trait that makes them extremely sensitive to what we call "losing face." This attitude seems to have had the most variant results: the extreme politeness as well as the frequent use of go-betweens.

Japanese ethics are not of a piece but are divided into different circles of loyalty, mostly corresponding to the obligations. It is easy to see how the circle of Chu (duty toward the Emperor), or the circle of Ko (duty toward the family) can easily conflict with the circle of Giri (ordinary obligation, vengeance of the name included) or the circle of human feelings. To overcome the difficulties resulting from this system the Japanese have developed systematic education in self-discipline to an almost incredible degree.

In accordance with certain trends in anthropology and psychology, Ruth Benedict explains the Japanese culture pattern largely through their methods of child rearing. Though she is above such silly fashions as "the sphincter control" theory of Gorer, it might be doubted whether the scientific foundations of this method in general are yet firm enough to give it such an exclusive position. Although it has no direct bearing on the author's analysis, it is perhaps sociologically not irrelevant that numerous "Japanese" traits would in a larger frame of reference appear as being of a far more general character, and be possibly combined with very different methods of child rearing.

In a last chapter the author discusses our present political relations with Japan. The author has used a great variety of sources: interviews, psychological tests, sacred legends, official documents, newspapers, novels, and movie plots. The book is a rich mine of insight and information, and in view of its author as well as its subject no longer commentary either on its intrinsic interest and importance or its accomplished craftsmanship is needed.

ERWIN H. ACKERKNECHT

PAPUA: *Its People and Its Promise—Past and Future.*

By Lewis Lett. F. W. Cheshire Pty., Melbourne. 7s. 6d. 108 pp. + 4 plates. 1944.

New Guinea, also known in the past as "Papua," is next to Greenland the largest non-continental land mass. To-day the term Papua is applied properly to the southern part of the eastern half of the island, this part forming the only Australian colony. The little book under review deals with Papua proper, which alone is half as large again as England. It has for its author one of the few old residents of the territory. He is not a scientist, but knows the country and its people intimately and can write entertainingly, drawing on his local experiences, which extend over more than three decades. The twelve chapters are all quite informal essays, ranging from "history" to "dreams and superstitions" and including brief accounts, from the layman's point of view, of the natives, their village life, their sorcery and former raiding and cannibalistic activities, and more authoritative reports on trading, native agriculture, and the possible future development of the colony. The latter, it seems, is not too bright; the soil is generally not fertile and is subject

to much erosion, and there are many limitations to the adaptability of the natives to radically changed conditions. Political and economic factors will inevitably play a more prominent role in the near future of Papua than will biological and anthropological considerations.

A. H. SCHULTZ

SANTA EULALIA. *The Religion of a Cuchumatán Indian Town. The University of Chicago Publications in Anthropology. Ethnological Series.*

By Oliver LaFarge. The University of Chicago Press, Chicago. $4.00. xx + 211 pp. + 14 plates. 1947.

Oliver La Farge, the well-known writer and anthropologist, during the summer of 1932 observed religious customs in Santa Eulalia, a township in the inaccessible mountains of northwestern Guatemala. Catholicism and the old Maya religion, the calendrical basis of which is well preserved, have formed here a strange alloy. I have analyzed studies by E. C. Parson, R. Beals, and T. Lynn Smith on similar combinations of native religions and Christianity in South and Central America in earlier issues of this journal. LaFarge's competent monograph will interest specialists in acculturation, the history of religion, the ethnography of the region, or Maya culture, "as these simpler folk who surrounded, and perhaps at times paid tribute to the great civilizations and spectacular kingdoms probably preserved ancient patterns underlying the more elaborate cultures, and remnants may survive to this day." The author's observations on relations between "ladinos" (the ruling "Spanish" minority) and Indians are of a more general interest.

ERWIN H. ACKERKNECHT

ENCYCLOPEDIA OF THE NEGRO. *Preparatory Volume with Reference Lists and Reports. Second Edition.*

By W. E. B. Du Bois and Guy B. Johnson; introduction by Anson Phelps Stokes. The Phelps-Stokes Fund, New York; The H. W. Wilson Company, New York. $3.25. 217 pp. 1946.

This revised edition of the preparatory volume contains the bibliographical reference lists and reports for the projected *Encyclopedia of the Negro*. The editors have contributed an introductory statement on the need for such a work. This is followed by (1) the alphabetical list of major subjects, with bibliographical notes; (2) a discussion of library resources for negro studies in the United States and abroad; and (3) a bibliography of bibliographies dealing with the negro. There are also three appendixes covering the organization of the project.

Many of the subjects listed have biological interest: acclimatization, acquired characteristics, adolescence, ages of man, Akeley, albino, alcohol, anatomy, animism, anthropology, anthropometry, archeology of Africa, artifacts, Aryan, Australia (negro in)—to cull a sample from the A's. Twelve years have now passed in the preparatory work. The appearance of the Encyclopedia itself will be welcomed by biologists among other scholars.

BENTLEY GLASS

BIOMETRY

SEQUENTIAL ANALYSIS. *Wiley Mathematical Statistics Series.*

By Abraham Wald. John Wiley & Sons, New York; Chapman & Hall, London. $4.00. xii + 212 pp. 1947.

During the war the Statistical Research Group of Columbia University issued a number of restricted reports on a statistical technique called sequential analysis. This book amplifies these earlier reports and makes them available to the scientific professions.

Sequential analysis is characterized by the fact that the number of observations is not determined in advance of an experiment. It provides a way of continuously checking observations against some hypothesis as each new datum is collected. Here, in short, is the answer to the question, "How many observations should I make in order that my results will have statistical significance?" By its very nature, this is an efficient kind of statistical analysis, since with this method one needs to collect fewer data, on the average, to obtain results as reliable as those obtained with conventional statistical procedures. The method proved especially useful during the war in checking the quality of manufactured items rolling from assembly lines. This book is still oriented toward that kind of application. But the technique should also have important applications in biological, psychological, and medical research. It should prove extremely valuable, for example, in determining the efficacy of alternative treatments in medical practice.

Even though it has great potential value, this book will probably have an extremely limited audience. The reviewer's experience in teaching and working with statistics convinces him that the author has greatly overestimated the mathematical sophistication of research men who will want to become acquainted with this type of analysis. Even those sections which were prepared for "readers with no advanced mathematical training" are very difficult. Readers who can follow the author, however, will find here a complete theoretical development of the method of sequential analysis. There is also a good section illustrating the application of the technique in testing certain kinds of hypotheses.

Another shortcoming—not so much of the book as of the method—is that this type of analysis has been developed to test only a fairly limited number of hypotheses. It in no sense replaces descriptive statistics nor many of the conventional statistical methods (correlation analysis and curve fitting, for example) which are used in the investigation of relationships between phenomena. The latter more commonly represent the goal of the research scientist.

A. CHAPANIS

A SIMPLIFIED GUIDE TO STATISTICS *for Psychology and Education. Revised.*

By G. Milton Smith. Rinehart & Company, New York. $1.25 (paper). xiv + 109 pp.; text ill. 1946.

This is a manual on elementary statistical methods. As the title implies, the illustrations and problems are chosen from the fields of psychology and education. The following topics are covered: frequency distributions, measures of central tendency and variability, the use of norms and standard scores, the normal curve, the significance of differences between means and percentages, correlation techniques (rank-difference, product-moment and biserial correlation), and chi-square.

As a text this has limited usefulness. It is probably too lengthy "to supplement the material in general and laboratory courses" and too short and sketchy for a course in elementary statistics. The weighting given the various topics leaves one with the impression that the author prepared it for some particular course he happened to be teaching. Chi-square, for example, receives much more space than does the product-moment correlation, although the latter is unquestionably the more important technique for the student's needs. The product-moment correlation is treated in such cursory fashion, in fact, that the student will only learn how to compute it for ungrouped data. The meaning and interpretation of a correlation coefficient and the concept of a regression equation are merely mentioned in passing.

The author's style is clear and the text is readable. It is unfortunate that the contents are not better balanced.

A. CHAPANIS

CYCLES: *The Science of Prediction.*

By Edward R. Dewey and Edwin F. Dakin. Henry Holt and Company, New York. $3.00. xii + 255 pp.; ill. 1947.

A few years ago the now defunct Literary Digest published the results of an investigation by Ernest Thompson-Seton on the fluctuation in the mean number of young in litters of rabbits, in which the conclusion was reached that its maximum value recurred in eleven year intervals coinciding with the maximum number of sunspots. A posthumous vindication of Thompson-Seton's discovery is supplied by the present work. Not only the magnitude of rabbit litters but also the stock exchange, atmospheric electricity, human emotion, the frequency of tent caterpillars, the price of wheat, the rate at which marriage licenses are applied for, and the activity of the real estate market, when plotted as time series, give a succession of peaks and valleys separated by approximately constant time intervals.

Naturally these cycles do not all have the same time period. In the case of the production of pig iron the cycle occupies three and one-half years, while that of the price of wheat is fifty-four years. Other variables recur in cycles between these extremes. In many instances cycles of different length combine so that their periods are obscured on the graph, and must be revealed by mathematical analysis.

The sub-title of this book—"the science of prediction"—indicates the importance of a knowledge of cycles to the business man. The advantage of being able to predict accurately the direction in which the market is likely to go in the near future is obvious. But the chief interest of the scientist is to learn what the factors may be which cause the market to move as it does.

In the present state of our knowledge it is much easier to describe how variables fluctuate than to explain why. That one of the factors involved is solar radiation seems clear. Perhaps the most significant paragraph in the book is the following, taken from the chapter in which solar activity is discussed:

"Our social sciences have tended to forget in the bravura of modern times, one fact which to many of the ancients was clear: Man is a child of the earth, and by that same token a part of it, and for this reason he must also be a child of the sun. If our modern research should find clear evidence that the rhythms of the sun dominate in man's life, as they dominate in many of the other phenomena our sciences study, only men too proud to remember their paternity should be surprised."

But before any categoric assertions can be made a great many more data must be analyzed. A few years ago the present reviewer heard a public speaker state that annual precipitation and solar activity went through a cycle of eleven years, and therefore that sunspots caused rain. A little while later he heard another public speaker declare the sunspots caused drought, while still later he heard a third lecturer deny that there was any connection between the two phenomena. Each of the three proved his assertions from the same set of figures—the Wolf numbers and the rainfall records of the weather bureau at San Diego.

The explanation of this inconsistency is clear. Any variable if plotted against time will give a series of crests and troughs, and any series of crests and troughs

can be broken down by Fourier analysis into a series of undulations of constant periodicity, and the more irregular the original time series the greater will be the number of component series required. When there are a great many component series it would be strange if one of them did not have a period similar to that of some different variable, and if the crests and troughs of the one do not coincide exactly with those of the other, it is merely necessary to postulate a time lag between cause and effect. But since the two series have equal periods, for every time lag between two crests there is a corresponding time lag between crest and trough. And if the two periods are not exactly equal they will coalesce into a greater period having the length of the least common multiple, in which there will be a time when crest coincides with crest, and another time when crest coincides with trough. In the case of solar activity and precipitation several pairs of periods are involved; in one pair the crests are coincident and in another they are staggered.

The business man is naturally not so much interested in cause and effect as he is in prognostication. For a long term investment a firmly established, going concern, that can be depended upon to bring in a fairly constant return in the long run despite alternating seasons of prosperity and depression, is preferable to a youthful concern whose rapid growth is offset by cyclic depressions, but for a short term investment the reverse may very well be the case.

In the present state of our knowledge the "practical" business man can learn more from a study of cycles than can the more "theoretic" scientist, and it is for the man of business that this work has been written. Perhaps that is why on the numerous graphs the cycles are represented by a zigzag of straight segments instead of by a smoothly flowing sine curve which would have been more accurate and would have given a better fit to the empiric data.

The absence of an analytic index detracts somewhat from the value of this book.

THE MONEY VALUE OF A MAN. *Revised Edition.* *By Louis I. Dublin and Alfred J. Lotka in collaboration with Mortimer Spiegelman. The Ronald Press Company, New York.* $6.00. xviii + 214 pp. 1946

This is the second edition of a unique book, the first edition of which appeared in 1930. The extensive social and economic changes which have taken place in the sixteen years between the two editions clearly necessitate re-evaluations of the money values computed in 1930. We would anticipate greater values associated with lowered interest and mortality rates. If, however, the revised edition embodied only these recomputations it would be disappointing, for the changes effected by certain social legislation have also affected the monetary value of a man. That the authors are fully aware of the effect of such changes is indicated by their thorough revision of the text as well as the tables. This revision involves the addition of three new chapters, The American Family (chap. 3), Income in Relation to Age and Economic Status (chap. 5), and Social Insurance in Relation to the Money Value of Man (chap. 12). The other chapters have been rewritten, with portions of the discussion of the earlier edition played down or deleted, as they have become less important with the passage of time; and some new material has been added. The comparison of the two editions makes an interesting study of the changes in certain phases of our social structure in the past two decades.

The authors stress at the outset that the book is confined to values that are capable of estimation in dollars and cents. They are concerned with the financial loss to the family if the wage earner dies, or suffers some impairment. They also consider to some extent the measure of such a loss to society. An historical survey of other inquiries into this problem points to the fundamental soundness of Farr's method of estimation, which is the one employed here, namely the determination of the present value of the future net earnings of a man, according to his age and income.

The tables in the appendices incorporate the results of such computations, based on a discount rate of 2½% (the earlier edition used 3½% and 4½%) and the life table of 1940. The various practical applications of such tables are considered, including assistance in insurance planning, in evaluating compensation, and in appraising the financial benefits of reduction in mortality.

Those familiar with the writings of Dublin and Lotka have learned to expect a stimulating array of ideas, and presentation of their subject from many points of view. This was true of the first edition of this book and is even more true of the second. Whether or not the reader fully agrees with all the estimations, many of which are admittedly difficult to arrive at, he is confronted with the necessity of considering the many factors involved in the problem. For example, the chapter on the American family presents evidence on the kinds of families making up our American society, the relation of mortality to marital status, the chances of marriage, its duration, the likelihood of disruption through death or divorce, the problem of orphanhood and old age dependency. The statistical evidence is presented in such a way as to interest readers of various degrees of statistical sophistication, and the numbers come alive, so that a visualization of the make-up of our society on certain axes emerges.

The book should be of interest to any individual trying to evaluate his own problem of personal responsibility—although it must be remembered that it deals primarily with averages—but it will be of still greater interest to the person interested in various phases of the social and economic problems of our modern society.

MARGARET MERRELL

STATISTICAL ANALYSIS IN BIOLOGY. *Second Edition. By K. Mather, with a foreword by R. A. Fisher. Interscience Publishers, New York.* $5.00. iv + 267 pp. 1946.

The first edition of this book was reviewed in the Q. R. B. 18: 299. 1943. None of the criticisms voiced at that time appear to have been met in making the revision, although a chapter on transformations (angular and probit) has been added. However, for those who are concerned principally with tests of significance and the analysis of variance and co-variance the book affords a good introduction.

DE OMNIBUS REBUS ET QUIBUSDEM ALIIS

TABER'S CYCLOPEDIC MEDICAL DICTIONARY *Including a Digest of Medical Subjects: Medicine, Surgery, Nursing, Dietetics, Physical Therapy. Fourth Edition. By Clarence Wilbur Taber and associates. F. A. Davis Company, Philadelphia.* $3.50 (indexed edition); $3.25 (plain or unindexed edition). xvi + 1477 pp.; ill. 1946.

The new edition of this medical dictionary has been completely reset. It now contains between 50,000 and 60,000 terms, with 273 illustrations, and runs close to 1500 pages. Each letter of the alphabet has been given separate page numbering. Because the volume is printed on fine, thin paper, it remains small and handy. Commendable editorial features include the elimination of diphthongs, of most hyphens, and of the annoying "see so-and-so" definitions. Many tables are included in the text, but those in the Appendix will prove specially useful. These include tables of units of measurement, physiological standards, muscles, arteries, veins, nerves, joints, foods, vitamins, abbreviations, physical constants, foreign phrases, Latin terms, and numerous others. Without question, this is a fine production. It is to be highly recommended to students, biologists, and physicians alike. It will probably be a rare occasion for anyone to need to refer from this to one of the larger medical dictionaries.

BENTLEY GLASS

RUSSIAN-ENGLISH TECHNICAL AND CHEMICAL DICTIONARY. *By Ludmilla Ignatiev Callaham. John Wiley & Sons, New York; Chapman & Hall, London.* $10.00. xviii + 794 pp. 1947.

This dictionary will doubtless prove useful to those wishing to follow the scientific literature published in Russian, and beginning to master the intricacies of that tongue. The technical languages of chemistry, chemical engineering, and mining are given a lion's share of the attention of the author, biological sciences being covered much less adequately. Nevertheless, a biologist will find this dictionary helpful, because of the large and well chosen vocabulary of words which, though not specifically biological, are likely to occur in biological or in any other technical publications.

TH. DOBZHANSKY

SCIENTIFIC INSTRUMENTS. *Edited by Herbert J. Cooper. Chemical Publishing Company, Brooklyn, New York.* $6.00. 305 pp. 1946.

In writing this book, fifteen contributors have collaborated in describing briefly hundreds of scientific and measuring instruments ranging from the mariner's compass to the electron microscope. The result is a strictly qualitative exposition, intended for non-specialists.

The book may be useful to some readers as a means of learning the most elementary principles of the construction and operation of instruments which are completely unfamiliar to them. Little more can be expected from a discussion which covers so much territory in so little space, and which at the same time assumes that the reader is completely naive about principles generally considered in a beginning physics course.

The treatment of the material is such as to make the book resemble an expanded dictionary or catalogue. The ultraviolet microscope is described in a single paragraph which stresses the higher resolution obtainable by the use of ultraviolet light as compared with visible light. No mention is made of the fact that the principal value of ultraviolet microscopy, especially to the biologist, is due to the fact that many naturally-occuring substances exhibit selective absorption in this region of the spectrum. Infra-red spectrometers and monochromators are described in five sentences and vacuum ultraviolet spectrographs in one sentence, with no mention of applications in either instance.

These are typical cases; such treatment must result in a highly superficial summary, and the authors have not attempted to counteract this by the use of any overall, meaningful pattern of presentation. The only references cited are a few general books on optics.

JOHN A. LOOFBOUROW

LITERATURE SEARCH ON THE PRESERVATION OF FOODS BY FREEZING. *Jointly Sponsored by the State Engineering Experiment Station and the Tennessee Valley Authority. Special Report Number 23. By B. H. Weil and Frances Sterne. State Engineering Experiment Station, Georgia School of Technology, Atlanta.* $4.00 (paper). viii + 409 pp. 1946.

The authors have abstracted 2095 papers on the preservation of foods by freezing. Foreign patents have been included, but articles dealing solely with the freezing of eggs or milk have been omitted. The index occupies 65 pages. This publication should promptly become an indispensable aid to all workers in this field.

THE DIFFUSION OF ELECTROLYTES AND MACROMOLECULES IN SOLUTION. *Annals of the New York Academy of Sciences, Volume XLVI, Article 5.*

By L. G. Longsworth, Charles O. Beckmann, Margaret M. Bender, Edward M. Bevilacqua, Ellen B. Bevilacqua, Douglas M. French, A. R. Gordon, Herbert S. Harned, Lars Onsager, Jerome L. Rosenberg, and J. W. Williams. New York Academy of Sciences. $2.00 (paper). Pp. 209-346 +2 plates. 1945.

This publication contains the following papers: The Diffusion of Electrolytes and Macromolecules in Solution—a Historical Survey, by L. G. Longsworth; Theories and Problems of Liquid Diffusion, by Lars Onsager; A Conductance Method for the Determination of the Diffusion Coefficients of Electrolytes, by H. S. Harned and D. M. French; The Diaphragm Cell method of Measuring Diffusion, by A. R. Gordon; Diffusion Constant Measurement in Theory and Practice, by E. M. Bevilacqua, Ellen B. Bevilacqua, Margaret M. Bender, and J. W. Williams; The Effects of Concentration and Polydispersity on the Diffusion Coefficients of High Polymers, by C. O. Beckmann and J. L. Rosenberg.

SCIENCE NEWS. *2. Atomic Energy Number. Edited by R. E. Peierls and John Enogat. Penguin Books, Harmondsworth, Middlesex; and New York.* 1s. (paper). viii + 168 pp. + 8 plates; text ill. 1947.

Among recent popular expositions of Atomic Energy, few can bear comparison with this inexpensive but outstanding little publication. Its contributors include R. E. Peierls, Hans A. Bethe, H. L. Anderson, P. Morrison, O. R. Frisch, M. Argo and E. Teller, all well-known active workers in the field. The style is simple, clear, non-technical. The chapter on radioactive tracers, by M. Argo and E. Teller, will be particularly interesting to biologists.

SYMPOSIA ON PRESENT DAY SOCIAL AND ECONOMIC ASPECTS OF NATIONAL HEALTH AND THE UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION, AND AMERICAN PARTICIPATION IN ITS ACTIVITIES. *Papers read before The American Philosophical Society Annual General Meeting, April 18, 19, 1946. Proceedings of the American Philosophical Society Held at Philadelphia for Promoting Useful Knowledge, Volume 90, Number 4.*

The American Philosophical Society, Philadelphia. $1.00 (paper). Pp. 249-317. 1946.

The first of these two symposia includes the following papers: The Health of the American People—an Historical Survey, by R. H. Shryock; Mental Hygiene, by W. Overholser; Role of Governmental Agencies in a National Health Program, by I. S. Falk; Convalescence and Rehabilitation, by H. A. Rusk; The Place of the Physician in Modern Society, by H. E. Sigerist; The Relationships between Governmental and Private Responsibilities for National Health, by W. A. Milliman; and Public Health Experiences in the European Theatre of Operations, by Major Gen. W. F. Draper. Everyone interested in public health and in the problem of socialized medicine will want to read these papers. They present a balanced and comprehensive view of the subject at the present standing.

The second symposium includes: The Background and antecedents of UNESCO, by W. G. Leland; The Role of Government in UNESCO, by C. A. Thomson; International Relations among Scientists, by D. V. Bronk; Intellectual Cooperation in the Social Sciences, by R. M. MacIver; and Problems of International Understanding, by J. M. Cooper. These brief papers should fall under the head of required reading for all American scientists. UNESCO has a great role to play in the education of the peoples of the world for peace, and without the full understanding and cooperation of Americans, it cannot succeed.